TIMER/COUNTER

INSTRUCTION MANUAL

SD 1038
Counter

SYSTRON-DONNER CORPORATION • 888 GALINDO STREET • CONCORD, CALIFORNIA 94520 • PHONE: (415) 682-6161 • TWX: 910-481-9478
IN EUROPE: SYSTRON-DONNER INTERNATIONAL, S. A. • 447 AVE. DE TERVUEREN • BRUXELLES 15, BELGIUM • R.C.B. 340.938

SERIAL NO.

DATE

INSTRUCTION MANUAL

MODEL 1038 COUNTER

SYSTRON DONNER
CORPORATION

CONCORD, CALIFORNIA

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Please specify both model and serial number in all correspondence concerning Systron-Donner instruments. Address all inquiries on operation or applications to your nearest sales representative or Sales Manager, Instruments, Systron-Donner Corporation, 888 Galindo Street, Concord, California.

Addendum Sheet

Model 1038, 100 Mc Universal Counter-Timer

The material in the Technical Manual that follows was prepared for the Model 1037, 50 Mc Counter-Timer. The Model 1038 is identical in method and type measurements. Electronically the instruments differ in the following area's only.

1. 100 Mc Amp & Decade
2. 100 Mc Readout
3. Type & Specifications of the Oscillator

Where necessary the correct schematics have been included for the Model 1038. The standard oscillator used in the Model 1038 is in this manual referred to as the B3 option, appropriate schematics are included and should be used for servicing.

The chart which follows outlines the specifications of the Model 1038 where they differ from those of the Model 1037.

Model 1038 Specifications

Frequency Measurements:

Range: 0 to 100 Mcs (dc input)

Ratio Measurements:

Range: F_1. . . .0 to 100 Mcs

Time Base:

Stability: Aging rate 3 parts in 10^9 per 24 hours after 72 hours warm-up. As a function of temperature - ± 2 parts in 10^{10} per ^{o}C from $-20^{o}C$ to $+55^{o}C$.

As a function of line voltage-less than ± 5 parts in 10^{10} for $\pm 10\%$ change in line voltage from 115V or 230V rms.

Short-term Stability:

± 2 Parts in 10^{10} rms with measurements averaging time of one second under constant environmental and line voltage conditions.

Adjustment Range:

Fine-4 parts in 10^8, Coarse-4 parts in 10^6

ADDENDUM SHEET

Model 1038

Your Model 1038 incorporates a new Oscillator board, number 17970, which replaces the older version described in the body of this manual. Briefly operation is as follows:

The 1 Mc oscillator signal is applied to a 1 Mc shaper (schmitt trigger Q1-Q2) and then to a driver (Q3). The driver output is applied to a double tuned times ten multiplier (Q4 and Q5), the 10 Mc output is available to the rest of the counter through Q6 and Q7 and then to the counter circuitry through P800-A.

In the 10 Mc position +30 volts is applied to Q7, turning it off, and to Q10 turning it off. Turning Q10 off enables Q8 and the 10 Mc time base from Q9 is applied to the counter through P800-A.

This change does not offset operations of the counter. Adjustment of the 10 Mc circuit is similar to that described in Section 5 of this manual.

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This change does not offset operations of the counter. Adjustment of the 10 Mc circuit is similar to that described in Section 5 of this manual.

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MODEL 1018 AND 1038

ERRATA SHEET

Page 3-6, Paragraph 3-41 should read as follows:

3-41 Rate- (C) Input Amplifier Check, The operation of this input channel on the basic Model 1018 or 1038 may be checked as follows:

1. Place the Function selector in the COUNT position.
2. Rotate the Trigger control to "-" extreme.
3. Press the RESET button.
4. With no input connected, rotate the trigger control to the "+" extreme, no count should be registered on the indicators
5. Rotate the trigger control again towards the "-" extreme. One count should be registered on the indicators.

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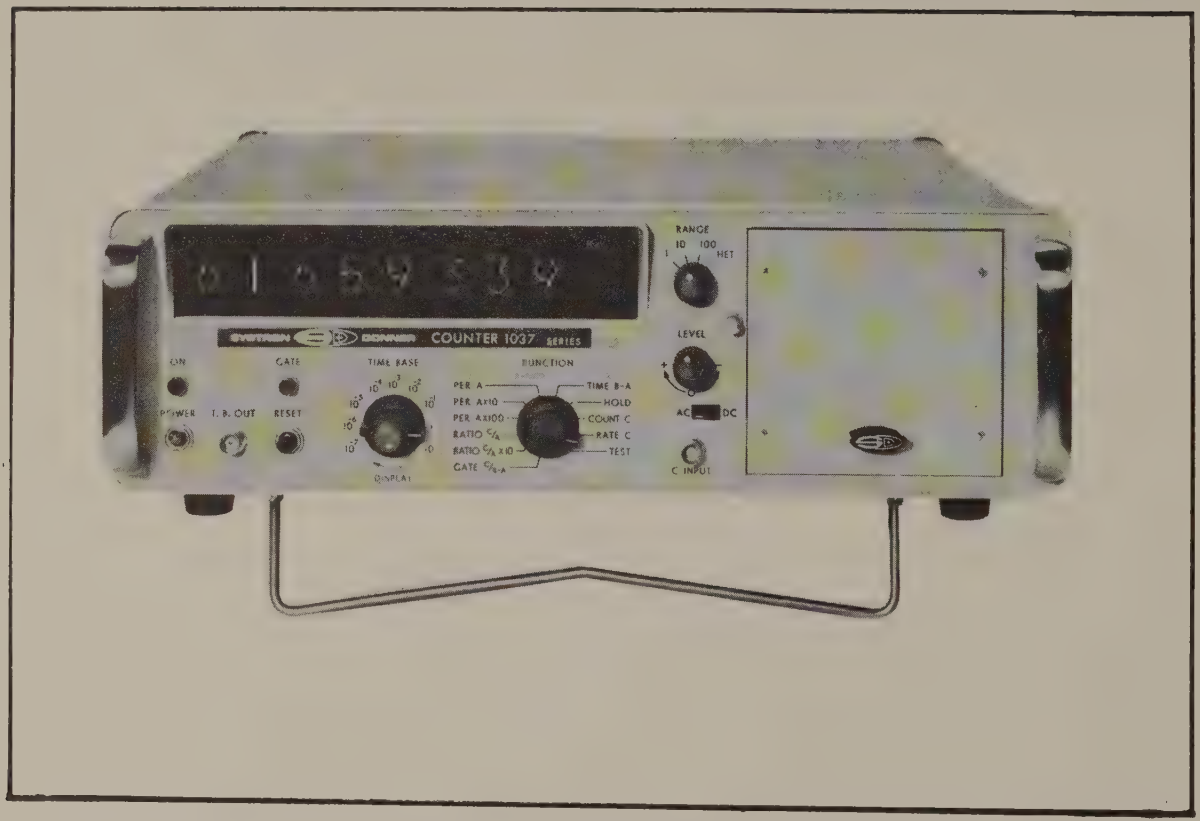


Figure 1-1 Model 1037 Counter

Chapter I — INTRODUCTION

MODEL 1038

1.1 BASIC FUNCTIONS

The Model 1038 counter is a solid-state instrument capable of direct frequency measurements up to 100 megahertz and period measurements with 0.1 microsecond resolution. The basic modes of measurement without the use of the optional front-panel plug-in modules include: Rate (frequency), Count (totalize), Period, Period X10, and Period X100. In the X10 or X100 functions the sum of ten (or one hundred) consecutive samples is displayed to obtain an average or more accurate reading.

1.2 STANDARD FEATURES

The Model 1038 is designed for simple reliable operation and easy maintenance. Its circuitry is fully transistorized and constructed on printed circuit plug-in modules. It has an eight digit in-line readout which displays the answer continuously until the end of the next measurement cycle.

Automatic decimal indication and units of measure indication are provided for all rate and period measurements. The time base generator is designed with a wide range of outputs (from 0.1 Hz to 10 MHz which are available at a front panel connector for external use. A 1 MHz frequency is also available externally at the rear panel.

In the standard Model 1038, the stability of the crystal oscillator in the time base is 3 parts in 10^8 per month. A switch, located on the rear panel, defeats the storage feature and allows the operator to observe the counting cycle. Additional control circuitry holds the indication of the counter for an adjustable length of time and then automatically resets the instrument to zero and repeats the measurement.

1.3 APPLICATIONS

The 1038 Counter can be employed for measurement, analysis, and counting of both periodic and random signal pulses of arbitrary waveshape within the rated frequency characteristics of the instrument. Because it operates directly from voltage inputs, it is an indispensable tool for designing, manufacturing, and testing of instruments and circuits having an electrical output relating to time interval, frequency, and number of occurrences. It is commonly used for the design and calibration of transmitting and receiving equipment, tuned circuits, crystals, etc. Because of its accuracy and stability, it is invaluable for checking long-term drift and heat-cycling stability of crystals and other signal generators. Other common applications are calibration of resolvers and synchros, and measuring gain-phase characteristics of closed loop servo systems.

When employed with suitable input transducers, such as photo cells, magnetic pickups, or switches, it becomes equally valuable for measuring physical events with respect to time, for example: speed of rotation, flow rate, time delays, or production unit counting. A list of typical applications includes:

> Frequency measurements; Relay and switch timing; Viscosity and ballistic measurements; Elasticity measurements; Tachometry; Telemetry; Pulse height and width analysis. Oscilloscope time base calibration; Flow, Strain, Force, Pressure measurements; Radiation counters.

1.4 TECHNIQUE

The 1038 is able to measure input signals of 100 megahertz per second or higher by virtue of a unique tunnel diode circuit based upon the familiar ring counter or shift register. In the frequency mode, the input signal is applied for a precisely controlled length of time to an electronic register consisting of the ring counter followed by seven decimal counting stages (''decades'') connected in series. Each of these stages drives a corresponding numeral indicator circuit. The count totalled on the indicators is the number of cycles of the input which occur during that time, thereby giving a frequency measurement.

Table 1-1 Model 1038 Frequency Counter Specifications

FREQUENCY MEASUREMENTS

Range: 0 Hz to 100 MHz (DC input). 10 Hz to 100 MHz (AC input)

Sensitivity: 100 mv rms or better from 0 Hz to 100 MHz

Gate Time: 1 μ sec to 10 seconds in decade steps.

Accuracy: ±1 count, ± time base error

Reads in: KHz and MHz

Self Check: Counts 10 MHz for the time chosen on the time base selector switch.

EXTERNAL SCALING

Frequency Range: 10 KHz to 2 MHz

Factor: By decades from 1 to 10^7

Input: Rear panel (1 MHz jack)

Output: Front panel (in place of T.B. out)

Sensitivity: 1 v rms

PERIOD MEASUREMENTS

Range: Single Period: 0 Hz to 1 MHz
Multiple Period: 0 Hz to 1 MHz

Periods Averaged: 1 to 10^2 in decade steps

Accuracy: ±1 count, ± time base error, ± trigger error*

Frequency Counted: 1 Hz to 10 MHz in decade steps.

Reads in: sec, ms, or μ s automatically

RATIO MEASUREMENTS (Using Rate Function)

Displays: $F_1/F_2 \times$ time base setting $\times 10^6$

Range: F_1 = 0 Hz to 100 MHz, F_2 = 10 KHz to 2 MHz

Sensitivity: F_1 = 0.1 v rms, F_2 = 1 v rms

Accuracy: Total error = ±1 count of F_1 ± trigger error* of F_2

Ratio Factors: 1 to 10^7 in decade steps.

*Trigger error is less than 0.3% of one period ÷ periods averaged for signals with 40 db or better signal-to-noise ratio.

TIME BASE

Frequency: 1 MHz (internal), 10 KHz to 2 MHz (external)

Stability:

Aging Rate: 3 parts in 10^9/24 hours after 72 hours

Long Term Aging Rage: 3 parts in 10^8/30 days

Aging Rate after 60 days continuous operation: < 3 parts in 10^9/24 hours

Short term aging rate averaged over 1 second period: 1 part in 10^{10} rms.

Ambient: ±9 parts in 10^9 per °C from −20°C to +25°C

Voltage: 5 parts in 10^{10} per 10% AC line voltage change.

OUTPUT FREQUENCIES

Rear Panel: 1 MHz at 1 v rms minimum, output Z = 1 KΩ nominal

Front Panel: 0.1 Hz to 10 MHz in decade steps, output Z = 470 Ω, nominal 6 v p-p rectangular waveform.

GENERAL SPECIFICATIONS

Registration: 8 digits in line plus units annunciator and automatically positioned decimal point.

Sample Rate: 0.2 sec to 5 seconds, or infinite

Operating Temperature Range: −20°C to +65°C

Storage Temperature Range: −55°C to +85°C

Signal Input:

Maximum Sensitivity: 100 mv rms

Coupling: AC or DC (switch selectable)

Attenuation: 1, 10, 100 (switch selectable)

Level: +1 volt to −1 volt × attenuation factor

Impedance: 100 KΩ/volt, 40 pf (approx.)

Overload: 1 volt range – 50 v rms, 10 volt range – 150 v rms, 100 volt range – 500 v rms

Dimensions: 5¼" high × 16-7/8" wide × 17" deep

Weight: Net: 33 lbs, Shipping: 52 lbs.

Power Requirements: Nominal 115 v or 230 v ± 10%, 50 to 60 Hz, 125 watts

Accessories Furnished: Coaxial cable, 6' with male BNC connector rack mount hardware for mounting in standard 19" rack instruction manual.

B HIGH-STABILITY OSCILLATOR

1. **Aging rate:** 1 part in 10^9/24 hrs.
2. **Warm-up time to reach specified aging rate:** 30 hrs.
3. **Aging rate after 60 days continuous operation:** 3 parts in 10^{10}/24 hrs.
4. **Accuracy 1 hour after turn-on referenced to previous turn-off:** 5 parts in 10^9 absolute from turn-off frequency.
5. **Short-term stability averaged over 1 second:** 1 part in 10^{10} rms.
6. **Long-term aging rate:** 3 parts in 10^8/30 days.
7. **Variation with temperature (average ±2 parts in 10^{10}/°C):** −20°C to +25°C: ±9 parts in 10^9, +25°C to +55 °C: ±6 parts in 10^9.
8. **Vibration (5-55 Hz, 0.016" DA):** ±2 parts in 10^8 (MIL-STD-167).
9. **Shock (50 G, 11 ms):** ±1 part in 10^8 (MIL STD-202A).
10. **±10% change in line voltage:** ±5 parts in 10^{10}.
11. **Storage temperature:** −65°C to +85°C.

B_3 MEDIUM-STABILITY OSCILLATOR

1. **Aging rate:** 3 parts in 10^9/24 hrs.
2. **Warm-up time to reach specified aging rate:** 72 hrs.
3. **Aging rate after 60 days continuous operation:** <3 parts in 10^9/24 hrs.
4. **Short-term stability averaged over 1 second:** 2 parts in 10^{10} rms.
5. **Long-term aging rate:** 2 parts in 10^8/7 days.
6. **Variation with temperature (average ±2 parts in 10^{10}/°C):** −20°C to +25°C: ±9 parts in 10^9, ±25°C to 55°C: ±6 parts in 10^9.
7. **±10% change in line voltage:** ±5 parts in 10^{10}.

B_4 SUPER HIGH-STABILITY OSCILLATOR

1. **Aging Rate:** 5 parts in 10^{10}/24 hrs.
2. **Warm-up time to reach specified aging rate:** 30 hrs.
3. **Aging rate after 60 days continuous operation:** 2 parts in 10^{10}/24 hrs.
4. **Accuracy 1 hour after turn-on referenced to previous turn-off:** 5 parts in 10^9 absolute from turn-off frequency.
5. **Short-term stability averaged over 1 second:** 1 part in 10^{10} rms.
6. **Long-term aging rate:** 1.5 parts in 10^8/30 days.
7. **Variation with temperature (average ±2 parts in 10^{10}/°C):** −20°C to +25°C: ±9 parts in 10^9, ±25°C to +55°C: ±6 parts in 10^9.
8. **Vibration (5-55 Hz, 0.016" DA):** ±2 parts in 10^8 (MIL STD-167).
9. **Shock (50 G, 11 ms):** ±1 part in 10^8 (MIL STD-202A).
10. **±10% change in line voltage:** ±5 parts in 10^{10}.
11. **Storage temperature:** −65°C to +85°C.

D_1 1-2-4-8 BCD DIGITAL OUTPUT

1. **Positive logic**
2. **'0' state at −6V ±0.5V.**
3. **'1' state at 0V ±0.5V.**
4. **Print Command:** +30V to 0V step
5. **Inhibit:** Contact closure to ground.
6. **Column Capacity:** 8 plus decimal point and units indication.

D_2 1-2-2-4 BCD DIGITAL OUTPUT

1. **Positive logic**
2. **'0' state at 0V ±1V, 0.5 ma MAX.**
3. **'1' state at +30V ±0.5V.**
4. **Print Command:** +30V to 0V step
5. **Inhibit:** Contact closure to ground.
6. **Column Capacity:** 8 plus decimal point and units indication.

E ADDITIONAL DECADES AND INDICATORS

F 1MΩ INPUT IMPEDANCE

Addition of FET input amplifier to increase input impedance to 1MΩ shunted by 25pf. Applicable to Models 1017, 1018, 1037 and 1038.

H POST-AMPLIFIER

Makes Model 1033 compatible with Model 1948A and Model 1034 compatible with Models 1291 and 1948A.

I SHIELDING

Addition of RFI shielding to conform to MIL STD 826.

TABLE 1-3 – INTERCHANGEABLE PLUG-INS

FREQUENCY EXTENDER GROUP

Model	Frequency Range	Function and Characteristics	Compatible with Counter
1297	12 GHz to 18 GHz	Transfer Oscillator. Input voltage Range: –30 dbm (7mv) to +10 dbm (0.7v). Measures CW, FM, and pulsed RF. Harmonic preset feature permits direct readout with counter accuracy (AFC mode). Requires external mixers	1017 1018 1037 1038
1292	50 MHz to 15 GHz	Transfer oscillator. Input voltage range: –50 dbm (700 μv) to +10 dbm (0.7v). Harmonic Preset feature permits direct readout with counter accuracy (AFC mode).	1017–1018 1037 1038
1255A	3 GHz to 12.4 GHz	Automatic transfer oscillator. Input sensitivity: –7 dbm (100 mv). Harmonic number computer and phase-locked oscillator permit automatic measurement of microwave frequencies.	1017 1018 1037 1038
1253	300 MHz to 3 GHz	Automatic transfer oscillator. Input sensitivity: –7 dbm (100 mv). Harmonic number computer and phase-locked oscillator permit automatic measurement of microwave frequencies.	1017–1018 1037 1038
1291	50 MHz to 500 MHz	Heterodyne Converter. Input voltage range: –15 dbm (50 mv) to +12 dbm (1v). Maintains counter accuracy while extending frequency range to 500 MHz.	1017–1018 1037 1038
1979H	0 Hz to 350 MHz	Prescaler. Input voltage range: –7 dbm (100 mv) to +12 dbm (1 v).	1017–1018 1037–1038

GENERAL PURPOSE GROUP

Model	Input Sensitivity	Function and Characteristics	Compatible with Counter
1948A	1 mv rms	Video Amplifier. Frequency Range: 10 Hz to 50 MHz. Increase input sensitivity.	1013-1017-1018 1033-1034H-1037-1038
1936		Integrating DVM. Range: 1v to 1000v. Input impedance: 1 MΩ or 1 MΩ/v full-scale, whichever is smaller. Features front-panel filter selection and automatic polarity indication.	1017–1018 1033–1034 1037–1038
1944	0.1 v	Preset. Permits counter measurement directly in Engineering Units. Functions available: rate x N, rate/N, period x N, period/N, count/N. N = 1 to 99999.	13–17–18 33H–34H 37–38
1925	0.3 v	Frequency-period. Frequency Range: DC to counter high range. Provides selection of start and stop slope and trigger level.	1033 1034
1926A	0.3 v	Time Interval measurement. Resolution to 0.1 μs dual channel with selection of input coupling, range, trigger level, and start and stope slope.	1013-1033-1034 1037–1038
1924	0.3 v	Time Interval measurement. Dual channel period measurement with automatic switching.	1013-1033-1034 1037–1038
1926	0.3 v	Time Interval measurement. Dual channel with gated input. Gated signal is counted during interval between A and B inputs.	1033 1034
1928	1 v pk/2 ns Rise	Time Interval measurement. Resolution 10 nanoseconds, selectable polarity and attenuation.	1018 1038

Chapter II — INSTALLATION

2.1 INITIAL INSPECTION

As soon as the instrument is received, verity that it is intact and as ordered. Inspect the instrument for any damage, such as scratched panel, broken knobs, or bent connectors. If damage of any nature is found, refer to the warranty inside the rear cover of this manual, and to subsection 2-3 for repackaging and shipping instructions.

As soon as possible, the instrument should be installed and given a thorough electrical inspection. The test given in the overall maintenance subsection is recommended for this purpose. Should the instrument fail to operate properly or fail to meet specifications, immediately contact your Systron-Donner representative.

2.2 INSTALLATION

The basic instrument is furnished with either a blank plug-in or one of the interchangeable plug-in units. (See Table 1-3 for plug-ins applicable to this instrument.) Either the blank plug-in or an interchangeable plug-in must be installed prior to operating the instrument. This is necessary to complete signal connections and provide proper air flow.

Installation of a plug-in is accomplished with the following steps:

a. Remove the plug-in or blank module presently installed in the counter by turning the locking knob (located to the left of the plug-in receptacle) at least 2 turns counter-clockwise. Pull the plug-in out by its handle. Generally, a firm pull is required to unseat the connector.

b. Place the new plug-in in the plug-in receptacle; push it in until flush with the counter front. A firm push may be necessary to seat the connector at the rear of the plug-in.

c. Lock the plug-in in place by turning the locking knob clockwise until tight. Check by giving the plug-in handle a firm pull. If it is not locked in, back off and tighten it again.

2.3 STORAGE AND RESHIPMENT

Environmental conditions during storage and shipment should be limited as follows:

Maximum Temperature: 185°F (85°C)
Minimum Temperature: -69°F (-55°C)

To protect your instrument during shipment or storage, use the best packaging methods available. Your Systron-Donner field office can provide materials similar to those used for original factory packaging. Contract packaging companies can provide dependable custom packaging on short notice.

General packaging instructions follow:

a. Wrap the instrument in heavy paper or plastic before placing it in the shipping container.

b. If possible, use the original container designed for the instrument. Otherwise, use a strong carton (350 lb./sq.in. bursting strength) or a wooden box to house the instrument.

c. Use plenty of packing material around all sides of the instrument and protect the front panel with cardboard strips.

d. Seal the package with strong tape or metal bands. Mark with "Delicate Instrument".

e. Refer to the warranty inside the rear cover of this manual and check with your Systron-Donner field office for shipping instructions. All correspondence should refer to an instrument by model number and full serial number.

2.4 POWER AND COOLING REQUIREMENTS

The instrument can operate from 115v or 230v ±10%, 50 to 60 Hz. It is normally supplied for 115v operation. To convert the power supply from 115v to 230v, remove the jumpers between Pins 1-2 and 3-4 on the rectifier board. Re-install a jumper between Pins 2-3. (Refer to the bottom view of the instrument in Section 4 for the location of the rectifier board.) The power requirement of the instrument with a blank plug-in installed is 125 watts.

The counter uses forced air cooling provided by a fan mounted on the rear panel. The counter should not be operated for long periods of time with the top or bottom dust cover removed, since this disturbs the air flow between the subassemblies. This includes rack-mounted installations.

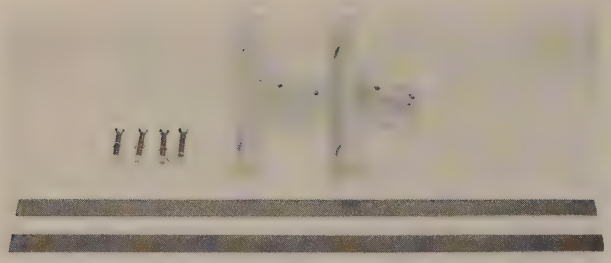


Figure 2-1 Rack Mount Adapter Kit

All instruments are shipped in a fully operable condition and are accompanied with a kit to permit rack mounting. If rack mounting is desired, the adapters are installed as follows:

a. Remove the two hold-down brackets on the rear panel. This will permit removal of the top and bottom dust covers and the two side channel trim strips.

b. Remove the rubber feet and collapsible stand from the bottom dust cover.

c. Verify that the rack-mount adapter kit contains the parts shown in Figure 2-1. This includes four each screws (Systron-Donner part number H1305), washers (No. H0658), and nuts (No. H0748); and two each trim strips (No. 17088) and mounting adapters (No. 17125).

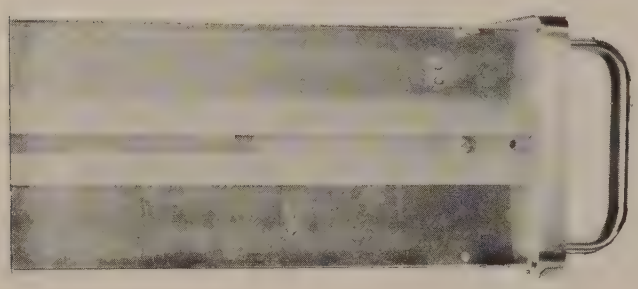


Figure 2-2 Adapter Mounting, Step d.

Figure 2-3 Adapter Mounting, Step e.

d. Remove the standard side channel trim strips and the front side channel mounting screws from the instrument. Figure 2-2 shows the left side (viewed from the front) of an instrument with the trim strip partially removed to expose the mounting screw.

e. Install the rack mounting adapters and special trim strips.

Figure 2-3 shows the left side of an instrument with the adapter and trim strip in place. The mounting screws have not been tightened down.

Figure 2-4 shows the interior of the left side of the instrument. The instrument has been placed on its side to facilitate placement of the washers and nuts on the mounting screws.

f. Replace the top and bottom dust covers and the hold-down brackets on the rear panel.

Figure 2-4 Left Side Mounting Detail

Chapter III — OPERATION

3.1 GENERAL

The counter is ready to test (except oscillator stability) in less than one minute after turning on the power switch. No preliminary adjustments or calibration procedures are required. It is advisable to read the following descriptions before using the counter.

3.2 USE OF CONTROLS, INDICATORS AND CONNECTORS

The following paragraphs and Figure 3-1 illustrate the use of the counters, controls, indicators and connectors.

> **WARNING**
>
> Dangerous voltages are present within the instrument with the power switch off. Disconnect all AC power before removing the instrument covers.

3.2.1 Power Switch

The power switch controls the AC line voltage to the instrument. When the power switch is off all AC power, except that applied to the oscillator oven is removed from the instrument. Thus the oscillator will maintain stability so long as the instrument is connected to a source of AC power.

NOTE:
The ovens in the optional high stability oscillators (B, B3, B4) are turned off by the power switch. The fast warm-up ovens used in these oscillators make continual power to them unnecessary.

3.2.2 Time Base Output Jack

The time base frequency selected by the TIME BASE selector switch is available at this front panel jack. (10 MHz to 0.1 Hz in decade steps.)

3.2.3 Manual Reset Switch

This pushbutton switch will manually reset the counter whenever it is engaged. When the manual reset switch is engaged the counter will reset to zero and, after a delay, begin its next counting cycle.

3.2.4 Gating Indicator

The gating indicator is on during the measurement interval and is off during the final count display interval. It provides a positive indication that the instrument is actually counting when the storage mode of display is being used. With storage disabled, the same function is provided by the changing readings of the indicators.

3.2.5 Time Base Selector

This switch selects one of the nine time base output frequencies which are used as the time reference for the RATE, PERIOD, or TIME interval measurements. They range from 0.1 Hertz to 10 Megahertz per second in decade steps, corresponding to time units of 10 seconds to 0.1 microsecond. This switch also controls the automatic decimal point indication in terms of kilohertz-per-second, or megahertz-per-second for measurements in the RATE function, and in terms of seconds, milliseconds, or microseconds for measurements made in the PERIOD or TIME Interval functions, as indicated by the annunciator located directly to the right of the readout. (NOTE: An asterisk (*) indication denotes that the positions of the time base and function switch are such that a valid measurement cannot be made.)

3.2.6 Display-Reset Control

The Display control (concentric with the Time Base Selector) is used to vary the duration of the count display over a range of approximately 0.1 to 5 seconds before the instrument is automatically reset for the next measurement cycle. Adjust this control for the desired repetition rate of the measurement as well as for convenience in reading the count. In the extreme clockwise position the display will remain until the Reset button is pressed. It is advisable to use this position when measuring non-recurrent inputs.

3.2.7 Function Selector

Set this switch to the desired position according to the discussion in Section 3.3. Use one of the X10 or X100 positions when it is desired to extend the Period or Ratio measurements for better accuracy.

3.2.8 Range Selector

The Range Selector has three ranges of attenuation plus a Het position. The appropriate range is determined by the amplitude of the input signal to be applied to the C Input or by the type of plug-in unit installed.

	RANGE		
	1	10	100
Minimum input voltage	.3V	3V	30V
Maximum operation voltage	10V	50V	150V
Maximum voltage without damage	50V	150V	500V

NOTE: All voltages are peak-to-peak. Values given are approximate.

The Het position is used with Models 1291, 1948A, 1936, 1979H and the ACTO series plug-ins. It makes a direct connection between the plug-in output and the counter input.

3.2.9 Trigger Level Control

The "Level" control on the Rate (C) input channel enables one to select the DC voltage level which will produce consistent triggering of the counting circuitry. The trigger voltage level for the C input is adjustable between approximately +1.0 volts and -1.0 volts with reference to the attenuated input signal. In terms of the unattenuated signal applied to the input jack, the trigger level is equal to the product of the selected attenuation factor and the trigger level voltage of the attenuated signal.

3.2.10 AC-DC Switch

This switch permits the choice of AC of DC coupling of the input signal. In the DC position, the channel will produce output pulses when the instantaneous DC level of input voltage exceeds the selected trigger level voltage. In the AC position, the DC component of the input signal is removed and the channel is triggered when the instantaneous value of the AC component of input voltage exceeds to the selected trigger voltage level. The specified input sensitivity of the instrument in the AC position is valid from 10 Hz up to the maximum rated frequency of the channel.

3.2.11 C Input Connector

The C Input Connector is the normal input for rate, count and period measurements. It is the input for the higher frequency in ratio measurements. If a time interval plug-in is installed its A input is used for period measurements instead of the C input.

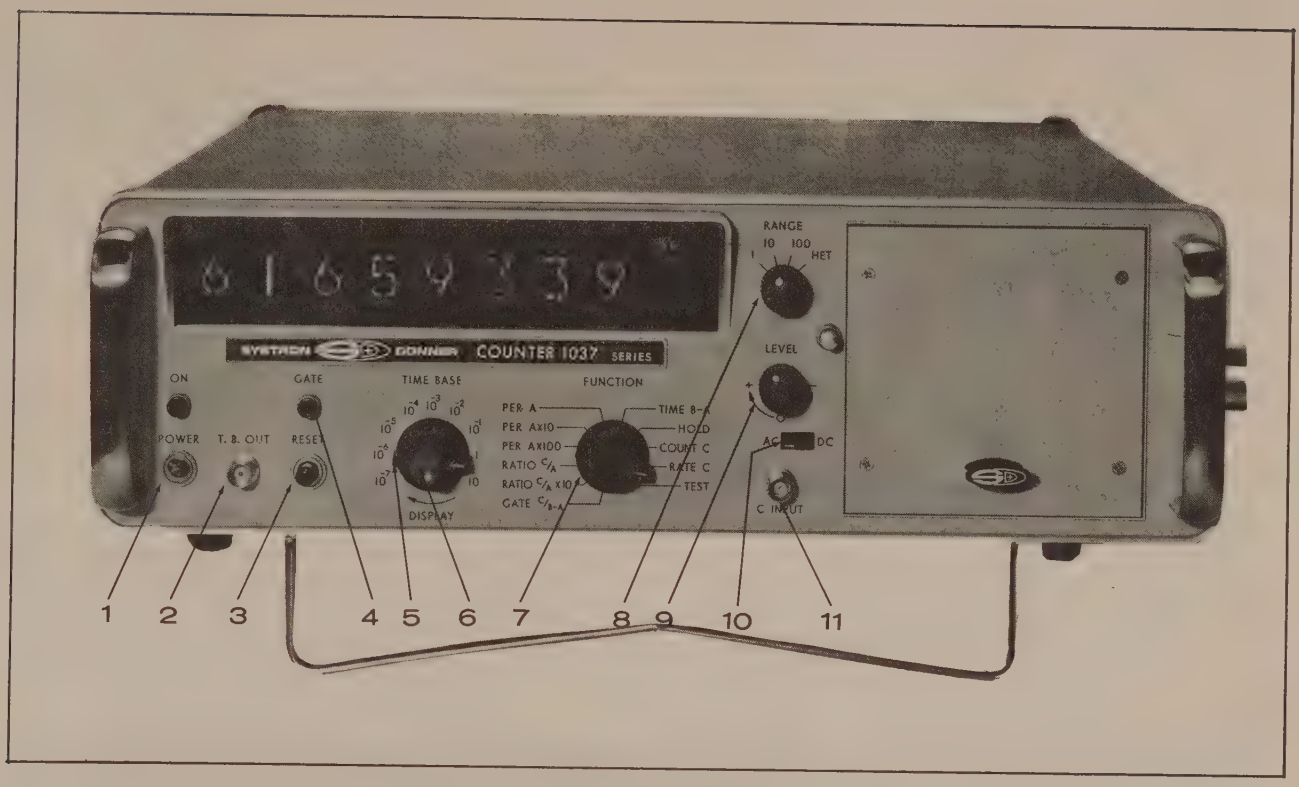


Figure 3-1 Front Panel, Universal Counter

(Model 1037 shown – all other models similiar)

1. **POWER:** Main On – Off Switch.
2. **T.B. OUT:** Time base output in decade steps from 0.1 Hz to 10 MHz selected by Time Base switch, 470Ω output impedance, 6 volt p-p rectangular waveform, stability same as internal time base.
3. **RESET:** Manual reset pushbutton.
4. **GATE LIGHT:** On when gate is open.
5. **TIME BASE:** Outer knob selects time base from 10 sec to 10^{-7}.
6. **DISPLAY:** Inner knob selects display time variable from 0.2 sec to 5 sec and infinite.
7. **FUNCTION SELECTOR TEST:** A self-check of counting circuitry with 10 MHz internal signal.

   RATE C: Measures frequency by counting each cycle during selectable time base period.

   COUNT C: Totalizes number of cycles applied to C input.

   HOLD: Turns gate off manually.

   TIME B-A: Measures time interval between signals applied to A and B inputs of Models 1926A, or 1924 plug-ins.

   PER A: Measures period of one cycle of input waveform applied to C input or A input of 1926A, 1924 or 1944 plug-ins.

   PER A x 10: Same as PER A but measures 10 cycles of input frequency.

   PER A x 100: Same as PER A but measures 100 cycles of input frequency.

   RATIO C/A: Counts number of cycles at C input during one cycle at A input of 1926A, 1924, or 1944 plug-ins.

   RATIO C/B-A: Counts number of cycles at C input during time interval between A and B inputs of 1926A or 1924 plug-ins.
8. **RANGE:** Selects attenuation factors of 1, 10 or 100 of signal applied to C input. HET position for Models 1291, 1948A, 1936, 1979 and ACTO plug-ins.
9. **LEVEL:** Selects dc trigger level point on input signal at C input from +1 volt to −1 volt times attenuation factor. This permits triggering on either positive or negative pulses at the dc level selected.
10. **AC-DC:** Selects direct-coupled input in DC position or 1 μf coupling capacitor in AC position.
11. **C INPUT:** Input signal jack.

3.2.12 Storage On-Off Switch

If the operator wishes to observe the counting portion of the operating cycle he may do so by placing the storage ON-OFF switch to off. Normally, this switch will be in the ON position and the readout will display the answers only.

3.2.13 1 MHz Output Jack

Located on the rear panel, this jack provides a 1 MHz, 1 v rms output, or with the INT-EXT switch in EXT it will accept a 10 KHz to 2 MHz input signal (amplitude of input must be 1 to 10 v rms.)

3.2.14 Internal-External Time Base Reference

Normally the counter is operated with the rear switch in the INTernal position. A one megahertz output signal is available at the adjacent 1 MHz in-out jack for use as a frequency standard for auxiliary equipment. If it is desired to operate the counter from an external reference frequency, change the switch to the EXTernal position and apply the external one megahertz reference to the same rear 1 MHz jack.

3.2.15 AC Line Fuses

Two 1.5 Amp slo-blo fuses in series with the AC line.

3.2.16 Decimal Output

Two fifty pin connectors for the optional decimal output. One ten line output for each digit indicator.

3.2.17 BCD Output

One fifty pin connector for the optional BCD output. One four line (1-2-4-8 or 1-2-2-4) output for each digit indicator.

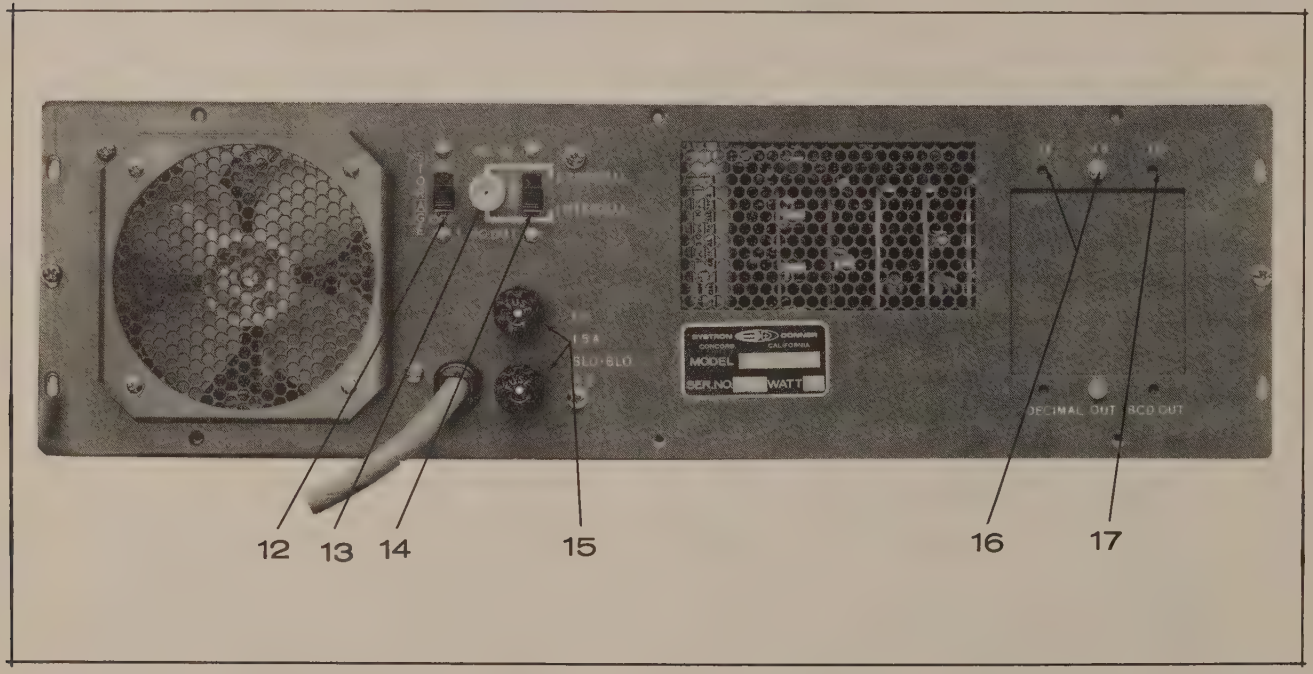


Figure 3-2 Rear Panel, Counter

12. **STORAGE ON-OFF SWITCH:** Disables power supply storage circuits, to enable an operator to observe counter indicators scale.

13. **1 MC JACK:** BNC connector for 1 MHz input when EXTERNAL-INTERNAL switch is in EXTERNAL. 1 MHz output for external use when switch is in INTERNAL POSITION.

14. **EXTERNAL-INTERNAL SWITCH:** In internal position the 1 MHz signal generated in the counter is used for the counter time base and is also available at the rear panel BNC connector as an output signal. In the external position the internal 1 MHz signal is disconnected from the BNC connector and the time base and an external signal must be connected to the rear panel BNC connector.

15. **FUSES:** Two 1.5 A slo-blo fuses in the AC power line.

16. **J4, J5 D OPTION:** Connector locations for interconnecting cable to printer.

17. **J6, D1 or D2 OPTIONS:** Connector location for interconnecting cable to printer.

3.3 OPERATION

The paragraphs that follow detail the operation of the counter. If critical measurements are to be made it is advisable to read section 3.4, Accuracy of Measurements, before proceeding.

All of the following procedures assume that the counter is on and warmed up. If a measurement requires a plug-in unit to be complete, a description of the plug-in's operation is included.

3.3.1 Test Function

1. Place the FUNCTION SWITCH in TEST.
2. Turn the DISPLAY control FULLY COUNTER-CLOCKWISE. (Minimum display time).
3. On the rear panel place the STORAGE switch to ON; the INTERNAL-EXTERNAL switch to INTERNAL.
4. Starting with 10^{-6}, place the TIME BASE switch in each of its positions while observing that the indications are as shown in the following table:

Time Base Position	Correct Indication
10^{-7} (0.1 μs)	Indication not valid
10^{-6} (1.0 μs)	00000010. MHz
10^{-5} (10 μs)	0000010.0 MHz
10^{-4} (100 μs)	000010.00 MHz
10^{-3} (1 ms)	00010.000 MHz
10^{-2} (10 ms)	0010000.0 KHz
10^{-1} (100 ms)	010000.00 KHz
1 (1 sec)	10000.000 KHz
10 (10 sec)	(1) 0000.0000 KHz

±1 count tolerance in this column

NOTE: For a complete acceptance test procedure refer to Section 4.2.

3.3.2 RATE C (Frequency) FUNCTION

1. Set the FUNCTION switch to RATE C.
2. Set the TIME BASE switch for the desired RESOLUTION as outlined in the table below:

Time Base Switch Position

Resolution	10^{-6}	10^{-5}	10^{-4}	10^{-3}	10^{-2}	10^{-1}	1	10
	1 MHz	100 KHz	10 KHz	1 KHz	100 Hz	10 Hz	1 Hz	0.1 Hz

3. On the rear panel set the INTERNAL-EXTERNAL switch to INTERNAL. Set the STORAGE ON-OFF Switch as DESIRED. (See Para. 3.2.12).
4. If the amplitude of the frequency to be measured is known set the RANGE switch in accordance with the following. If input amplitude is from 0.3V to 6V pk-to-pk set range to 1; if from 6V to 40V pk-to-pk set range to 10; if above 40V pk-to-pk set range to 100.

CAUTION!

The counter will not operate properly with input signals above 150 V pk-to-pk.

WARNING!

Signals above 500 V pk-to-pk will cause damage to the instrument. See para. 3.2.8.

If the amplitude of the frequency to be measured is unknown set the range switch to 100 and attempt to make the measurement. If a measurement cannot be made with the range switch in 100 try again with the range switch in 10; if unsuccessful try a third time with the range switch in 1.

5. Apply the signal to be measured to the C input.
6. Set the AC-DC switch as desired. (See para.3.2.10).
7. ROTATE the LEVEL control until a stable count is observed on the indicators. If no count is observed place the range switch in the next lower position. If a stable count cannot be achieved, check the input signal for frequency, amplitude and stability.

Note: It is normal for the digits on the right to vary. Most input signals will have enough instability to cause some variation.

3.3.3 Count Function

1. Set the range switch as explained in paragraph 3.3.2. (Rate Function).
2. Apply the signal to be counted to the C input.
3. Set the AC-DC switch as desired (See para. 3.2.10).
4. Place the FUNCTION switch to count C.

5. Rotate the level control until the indicators begin to cycle. (Cycling will be shown as the storage feature is automatically defeated in count C).

6. If the count is to be started at a particular point in time, place the function switch in HOLD which will stop the count; push the reset switch to set the indicators to zero; then return the function switch to count C at the time the count is to begin.

3.3.4 Hold Function

(used only in combination with the Count C function).

1. Set the FUNCTION switch to hold. The count will stop and remain displayed. The count may be set to zero by pushing the reset switch.

2. To resume the count or to start a new count return the function switch to Count C.

3.3.5 Time B-A Function

Note: This function is available only when a Model 1924 or 1926A plug-in unit is installed. For a detailed description of the operation of these plug-ins refer to their respective instruction manuals.

1. Set the counter controls as follows:

   (a) Set the FUNCTION switch to TIME B-A.

   (b) Set the TIME BASE switch for the desired RESOLUTION as shown on the following chart:

Time Base Switch Position

Resolution	10^{-7} 0.1 μs	10^{-6} 1 μs	10^{-5} 10 μs	10^{-4} 100 μs	10^{-3} 1 ms	10^{-2} 10 ms	10^{-1} 100 ms	1 1 sec	10 10 sec

2. Set the plug-in controls as follows:

   (a) Set the SEP-COM switch to SEP.

   (b) Set both A and B channel AC-DC switches as desired. (See para. 3.2.10 as the discussion there is valid for the plug-ins).

   (c) Set both A and B channel slope switches as desired. With slope switches set to negative the unit will trigger on negative going slope of the input signal. It is not necessary to set both switches to the same polarity.

   (d) Set both A and B channel range switches to the appropriate position as determined by the input signal amplitude.

   (e) Apply the signal that is to START the measurement interval to the A INPUT. Apply the signal that is to STOP the measurement interval to the B INPUT.

   (f) Rotate the A channel trigger level control until the gate light on the counter comes on. (or with the storage ON-OFF switch in OFF – Rotate the trigger level control until the counter just starts to cycle).

   (g) Rotate the B channel trigger level control until the gate light on the counter just goes out and then begins to blink. The rate at which the gate light blinks is determined by the setting of the display control. (or with the storage ON-OFF switch OFF – rotate the trigger level control until the counter stops cycling and displays an answer.

3.3.6 Period Function

CAUTION

If a Model 1924 or 1926A plug-in is installed period and multiple period measurements must be made using the A input and controls on the plug-in. Although a different input and controls are used the procedure remains the same otherwise.

1. Set the FUNCTION switch to PER A.

2. Set the range (para. 3.3.2 step 4) and AC-DC (para. 3.3.2 step 6) switches as previously described for the rate function.

3. Set the time base switch for the desired resolution (see chart in para. 3.3.5 step 1).

4. Apply the signal to be measured to the C input.

5. Rotate the level control until a stable indication is displayed. If no indication is displayed select the next lower range position. If the indication is unstable check the frequency, amplitude and stability of the input signal.

Note: It is normal for the digits on the right to vary. most input signals will have enough instability to cause some variation.

3.3.7 Multiple Period (X10, X100...) Functions

1. Perform a normal period measurement as described in para. 3.3.7.
2. Place the function switch in the desired period multiple and read the indication.

3.3.8 Ratio C/A Function

Note: This function is available only with a Model 1924 or 1926A plug-in installed.

1. Apply the LOWER frequency input to the A input of the plug-in.
2. Apply the higher frequency input to the C input of the counter.
3. Set the FUNCTION SWITCH to RATE C and make a normal rate measurement as described in para. 3.3.2.
4. Set the FUNCTION switch to PER A and make a normal period measurement as described in para. 3.3.6.
5. Set the FUNCTION switch to RATIO C/A. The counter indication will be the ratio between the C and A inputs.

3.3.9 Multiple Ratio C/A (X10, ...) Functions

1. Make a normal ratio C/A measurement is described in para. 3.3.8.
2. Select the desired multiple and read the indication.

3.3.10 Gate C/B-A Function

Note: This function is available only with a Model 1924 or 1926A plug-in installed.

1. Apply the signals that are to determine the B-A interval to the A and B inputs of the plug-in.
2. Apply the signal that is to be counted during the B-A interval to the C input of the counter.
3. Set the function switch to Rate C and make a rate measurement as described in para. 3.3.2.
4. Set the function switch to time B-A and make a time B-A measurement as described in paragraph 3.3.5.
5. Set the function switch to Gate C/B-A. The indication will read the number of events that occur at the C input during the time interval between events A and B.

3.3.11 Scaling

Scaling is accomplished by applying the signal to be scaled to the 1 MHz output jack at the rear of the counter while the INT-EXT switch is in EXT. To scale a signal proceed as follows:

1. Place the INT-EXT switch in Ext.
2. Ascertain that the signal to be scaled is within the following limits:

   Frequency – 10 KHz to 2 MHz minimum
   Minimum Amplitude – 1 V rms.
   Maximum amplitude – 10 V rms.
3. Connect the signal to the 1 MHz output jack.
4. The scaled signal is available at the T.B. out jack on the front panel of the counter. The scale factor is selected, in decade steps, by the time base switch. The table which follows shows the scale factors available.

Time Base Switch Position

Scaled Signal divided by	10^{-7}	10^{-6}	10^{-5}	10^{-4}	10^{-3}	10^{-2}	10^{-1}	1	10
	N/A	1	10	100	1 K	10 K	100K	1 M	10 M

3.3.12 Ratio Measurement using Rate Function

Ratio measurements may be made in the rate function by using the rate and scaling functions together. Proceed as follows:

1. Apply the lower of the two frequencies to be used to the 1 MHz output jack and proceed as in the scaling procedure described in paragraph 3.3.11.
2. Apply the higher of the two frequencies to the C input of the counter and proceed as in the normal rate measurement described in paragraph 3.3.2.
3. The counter indication will be the C input frequency divided by the EXT input frequency times the time base switch position, or

$$\text{Ratio} = \frac{\text{C input}}{\text{EXT input X T.B. position.}}$$

The ratio is direct with the time base switch in 10^{-6} and is multiplied by a decade factor in each succeeding time base position as shown in the following chart:

Time Base Switch Position

Ratio:	10^{-7}	10^{-6}	10^{-5}	10^{-4}	10^{-3}	10^{-2}	10^{-1}	1	10
C input / Ext Input	N/A	1	10	100	1K	10K	100K	1M	10M

3.4 ACCURACY OF MEASUREMENTS

There are several factors which may cause errors in measurements made with the counter. The paragraphs which follow discuss all of the various possible sources of error and how to minimize their effects. It is important that the operator read and understand these discussions if he is to obtain the best possible results from the counter.

3.4.1 Oscillator Stability:

Digital frequency measurements are subject to several types of errors. One of the most significant is the accuracy of the timing interval, as determined by stability of the crystal-controlled oscillator. Aging rates for the types of oscillators used in counters range from 1 part in 10^6 per day to 5 parts in 10^{10} per day. Other causes of oscillator instability are temperature variations and line voltage changes.

Errors due to oscillator instability may be reduced by the following techniques:

1. By leaving the counter on all the time. The aging rate of an oscillator is greatest when it is first turned on. As an example, the high stability oscillator available for Systron-Donner counters has an aging rate of 1 part in 10^9/24 hours after 30 hours continuous operation. After 60 days continuous operation the aging rate will have improved to 2 parts in 10^{10}/24.

2. By frequent calibration with a frequency standard. Periodic comparison against a primary frequency standard will enable the operator to adjust the oscillator and correct for drift.

3. An external oscillator may be used in place of the standard internal oscillator. If an oscillator with better stability that that of the counter is readily available it should be used.

3.4.2 Gating Error

Gating error is responsible for a possible error of ±1 count (in the 1's digit) in almost all types of measurements. This error is possible because the incoming signal passing through the count gate is not synchronized with the time base pulses which control the gate.

As demonstrated in Figure 3-3 the first or last cycle of input signal may or may not pass through the gate during the selected measurement interval.

For high frequency measurements, the ±1 count gating error is insignificant compared to the total count. At low frequencies, however, the error may become important. For this reason the period mode of measurement is normally used to obtain greater accuracy. Figure 3-4 shows which type of measurement will yield the lowest gating error.

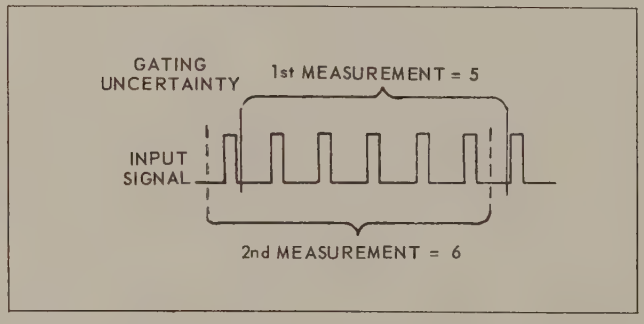


Figure 3-3 Possible Error Caused by Gating

Gating error can be reduced by a factor of 10 by extending the interval of measurement (Period X10, etc.) The total count is multiplied by 10 but the gating error remains ±1 count. Longer timing intervals may be provided automatically or by manual control using the "count" mode.

For example, if a 10 KHz signal is measured over a 0.1 second time base, the count indicated would be 1000 ±1 and the percentage of error would be ±0.1%. Measured over a 1 second time base, the count indicated would be 10000 ±1 and the percentage of error would be reduced to ±0.01%.

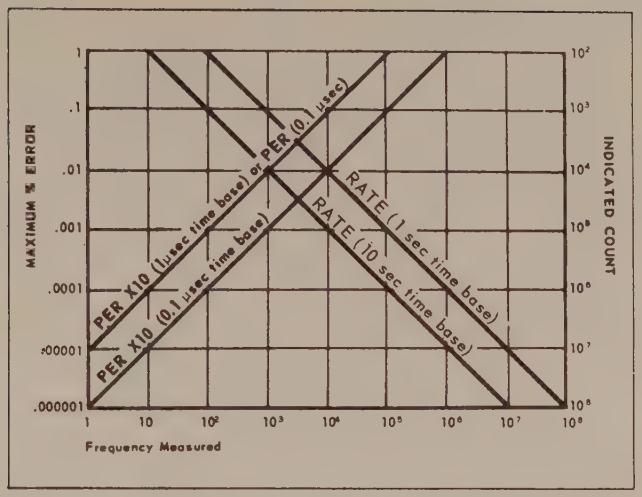

MAXIMUM % ERROR
INDICATED COUNT
Frequency Measured
PER X10 (1 μsec time base)
PER X10 (0.1 μsec time base)
PER (0.1 μsec)
RATE (1 sec time base)
RATE (10 sec time base)

Figure 3-4 Gating Error for Rate vs. Period Measurements

3.4.3 Count Error Produced by Noise in Frequency Measurements

Noise superimposed on the input waveform may cause spurious count pulses to appear at the output of the amplifier and, consequently, to be counted. An output pulse occurs and is counted each time the input signal crosses and re-crosses the selected amplifier trigger voltage level, as shown in Figure 3-5. Since an input signal cycle must usually have amplitude of at least 0.2 to 0.3 volts peak-to-peak to cause triggering, spurious counts can be eliminated by attenuating the total input + noise signal to a suitable amplitude. It is important to have both attenuator and trigger level controls set properly when measuring signals under marginal conditions of noise.

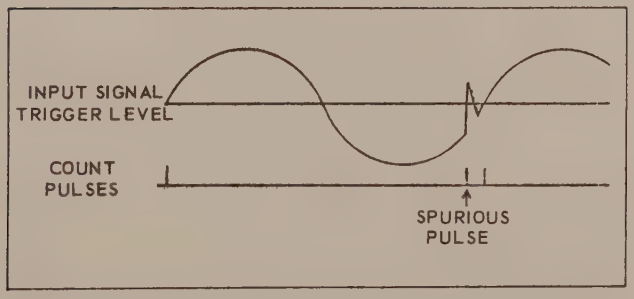


Figure 3-5 Spurious Counts from Noise Superimposed on Input Signal

3.4.4 Loading Error

One frequently overlooked and generally not significant error may occur if the connection of the instrument to the external signal causes a frequency or amplitude shift of the external signal. This error will only be noticed with signal sources of relatively high impedance or high frequency as compared to the input impedance and frequency rating of the counter.

For signals of sufficient amplitude the loading error can be reduced by placing either a small coupling capacitor or a large resistor in series with the input signal. The isolating component should be located at the signal source so that it will also isolate the cable capacity.

The loading caused by connecting the input impedance of the start and stop channels to a specific signal source can be calculated to determine if the source of error is significant. For example, if a counter with a 10 megohm input impedance is used with a signal source having a 10,000 ohm output impedance, the effective value of this resistor is changed by approximately 0.1%. This would be equivalent to shifting the phase of a 60 cycle signal by approximately 0.23 degrees.

3.4.5 Trigger Error

In addition to gating error, oscillator drift, and loading errors, the Period and related Time interval measurements are subject to a trigger time error caused by noise on the input signal.

The total signal may be considered as an ideal noise-free signal with a super-imposed noise signal. The noise, added to the ideal signal, may trigger the channel before or after the selected instant for triggering. The maximum error in time for a given peak-to-peak noise voltage (V_n) and the slope of the ideal signal at the trigger level is:

$$t\ (\text{sec}) = \frac{Vn \quad (\text{volts})}{\text{Slope} \quad (\text{volts/sec})}$$

The maximum percent error is:

$$\text{Max. \% error} = \frac{t \times 100 \quad (\text{sec})}{T \quad (\text{sec})}$$

For a sine wave triggering at its zero cross-over point:

$$\text{Max. \% error} \pm \frac{Vn \times 100 \quad (\text{volts})}{Vs \quad (\text{volts})}$$

This error effectively lengthens or shortens the period measurement, as depicted in Figure 3-6. The percentage of error is given by the formula 100 ÷ T, where T is the actual period and is the trigger error (in seconds).

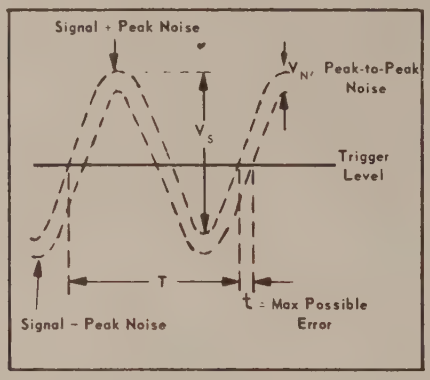


Figure 3-6 How Noise Produces Triggering Error

From the foregoing discussion, it can be seen that as the amplitude of signal voltage is increased, the percentage of error is diminished. In addition, if the trigger level is set at the center of the steepest slope of the waveform, the maximum error will be reduced.

Another way to reduce trigger error is to measure multiple periods of the gating signal. Since this error occurs only with the first and last pulses of the measuring interval, the trigger error will be reduced by a factor of 1/N if the measurement is extended for N periods.

3.4.6 Total Error

The various errors add up in the following manner to form the total error for each of the functions:

Total Error

Function	Errors Present
RATE	Gating + Drift + Loading
PERIOD & TIME	Gating + Drift + Trigger + Loading
RATIO & GATE	Gating + Trigger + Loading

Chapter IV — UNIT DESCRIPTION

4.1 GENERAL

The counter is composed of four basic elements: an input amplifier, a time base circuit, a switching circuit, and a counting circuit. Changing the relationship of these basic elements with the function switch enables the counter to perform its various functions. In addition, use of the interchangeable plug-ins (see Table 2-2) increases the flexibility of the input circuitry.

The basic counter is capable of counting, and of performing rate and period measurements. With some limitations, the counter can also perform ratio measurements and input signal decade scaling. This section describes the basic counter elements and their interconnection to perform these functions.

4.2 BASIC CIRCUITS

Shaping and amplification of the input signal are accomplished by the input amplifier. The front panel controls for C-input coupling (AC/DC switch, RANGE switch and trigger LEVEL control) all connect to this amplifier. Outputs from the amplifier feed the switching circuit as either "count" or "start/stop" signals, depending on the operation being performed. When certain of the interchangeable plug-ins are used in the counter, the functions of the input amplifier are performed by the plug-in.

The counter time base provides the precise frequencies needed for rate and period measurements. Both multiplier and divider circuits process the output of a crystal oscillator to provide the frequencies required by the counter. The front-panel TIME BASE and FUNCTION switches determine the disposition of these frequencies. Outputs from the time base are sent to the switching circuit as either "count" or "start/stop" signals, and, in some cases, to the installed plug-in. A switch and jack on the rear-panel permit the use of an external oscillator. The T.B. OUT jack on the front-panel allows access to the selected scaled output of the time base or external oscillator input.

The switching circuit regulates the passage of the trigger signal to the counting circuit. There are two elements in the switching circuit: a gate generator that receives "start/stop" signals and produces a control gate signal and an electronic switch that receives a "count" signal and produces the counting circuit trigger. The source of the "count" and "start/stop" signals is controlled by the front-panel FUNCTION switch. Front-panel indication of the condition of the switching circuit is provided by the GATE lamp which is on when the switch is closed.

The counting circuit is a chain of decades, or divide-by-ten elements, with their associated indicators and reset circuitry. Selection of decimal point and annunciator are also functions of this circuit. The front-panel DISPLAY control and RESET button are associated with this circuit, as is the rear-panel STORAGE switch.

4.3 FUNCTIONS

The front-panel FUNCTION switch selects the six basic modes of operation and the TEST function as described in the following paragraphs.

> NOTE: Some interchangeable plug-ins pre-empt the input circuits, making use of the C INPUT impossible in some functions. Refer to the Operation Section of the plug-in manual and Section 3 of this manual for any operating limitations.

4.3.1 COUNT (Totalize)

The instrument counts the number of cycles of a signal at the C INPUT during the arbitrary period of time that the FUNCTION switch is in the COUNT position. Refer to Figure 4-1. Switching to the HOLD position terminates the count, making the input manually controlled. There is no decimal point or unit indication in this function.

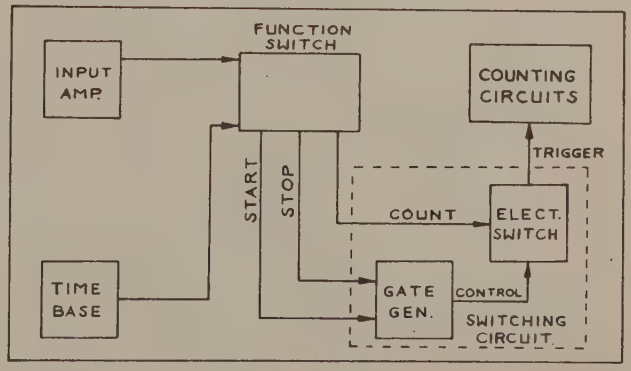
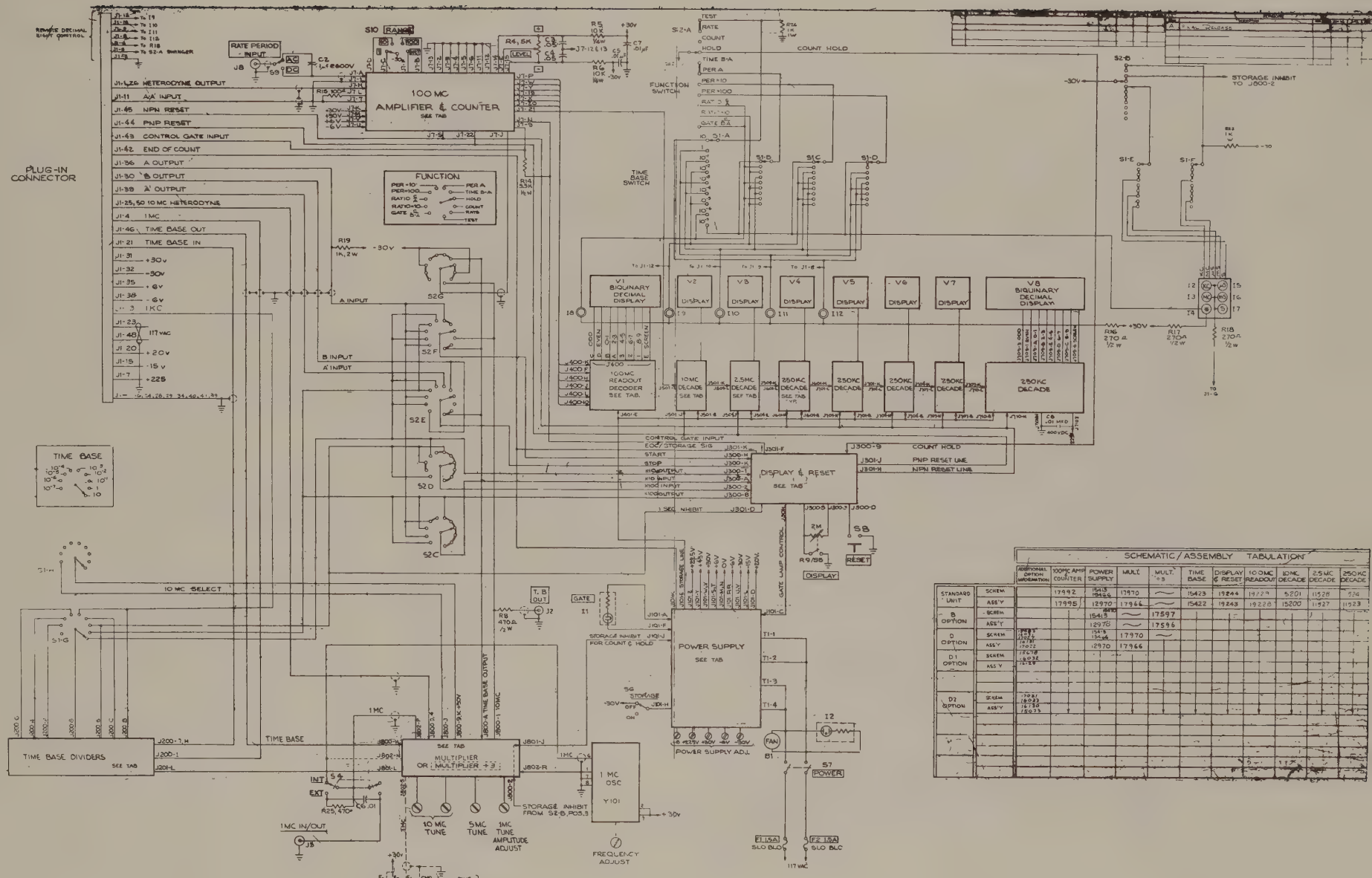


Figure 4-1 Count (Totalize)

Table 4-2 Schematic/Assembly Tabulation*

1037 Type		Additional Option Information	50 Mc Ampl. & Decade (5)	Power Supply (11)	Mult. & Osc. (7)	Mult. ÷3 (7)	Time Base (8)	Display & Reset (9)	50 Mc Readout (6)	10 Mc Decade (10)	2.5 Mc Decade (10)	250 Kc Decade (10)
Standard Unit	Schem.	→	13531	15413 15460	10555	None	15423	14881	12977	15115	10364	10363
(4) thru (13)	Ass'y	→	13534	15412	11095	None	15422	15391	12242	15116	13269	10504
B Option (1) (7) (13)	Schem.	→	↑	15460 15470 15413	None	12980	↑	↑	↑	↑	↑	↑
	Ass'y	→		15412	None	12983						
D Option 10 Line (4) (10)	Schem	13683, 16031 17027	Std. Unit	Std. Unit	Std. Unit	Std. Unit	Std. Unit	Std. Unit	Std. Unit	Std. Unit	Std. Unit	Std. Unit
	Ass'y	16131, 17022	↓	Std. Unit	Std. Unit	Std. Unit	Std. Unit	Std. Unit	Std. Unit	Std. Unit	Std. Unit	Std. Unit
D1 Option 1-2-4-8 (4) (10)	Schem	15618, 16038	↓	↓	↓	↓	↓	↓	↓ 12977	↓	↓	↓
	Ass'y	16129	↓	↓	↓	↓	↓	↓	15661	↓	↓	↓
S Option (Storage) (6) (10) thru (13)	Schem	→	↓	15413 15466	↓	↓	↓	↓	12978	15201	11528	11524
	Ass'y	→	↓	12970	↓	↓	↓	↓	12979	15200	11527	11523
D2 Option 1-2-2-4 (4) (10)	Schem	17021 16033	↓	Std. Unit	↓	↓	↓	↓	Std. Unit	Std. Unit	Std. Unit	Std. Unit
	Ass'y	16130 15073	↓	Std. Unit	↓	↓	↓	↓	Std. Unit	Std. Unit	Std. Unit	Std. Unit
B3 Option (11)	Schem	→	↓	15847 15460 15413	↓	↓	↓	↓	↓	↓	↓	↓
	Ass'y	→	↓	15412	↓	↓	↓	↓	↓	↓	↓	↓
P Rack Mount (2)	Schem	→	↓	Std.	↓	↓	↓	↓	↓	↓	↓	↓
	Ass'y	→	↓	Std.	↓	↓	↓	↓	↓	↓	↓	↓
D1 S (4) (6) (10)	Schem	15678 16032	↓	15413 15466	↓	↓	↓	↓	12978	15201	11528	11524
	Assy	16129	↓	12970	↓	↓	↓	↓	15577	15200	11527	11523

* Numbers in parentheses indicate applicable section numbers in this manual.


PLUG-IN CONNECTOR
100 MC AMPLIFIER & COUNTER
SEE TAB
FUNCTION
FUNCTION SWITCH
TIME BASE SWITCH
V1 BIQUINARY DECIMAL DISPLAY
V2 DISPLAY
V3 DISPLAY
V4 DISPLAY
V5 DISPLAY
V6 DISPLAY
V7 DISPLAY
V8 BIQUINARY DECIMAL DISPLAY
100MC READOUT DECODER SEE TAB.
10MC DECADE SEE TAB
2.5MC DECADE SEE TAB
250KC DECADE SEE TAB
250KC DECADE
DISPLAY & RESET
SEE TAB
POWER SUPPLY
SEE TAB
POWER SUPPLY ADJ.
TIME BASE DIVIDERS
SEE TAB
MULTIPLIER OR MULTIPLIER ÷ 3
1 MC OSC Y101
TIME BASE
10 MC SELECT
RATE PERIOD - INPUT
STORAGE INHIBIT TO J800-2
COUNT HOLD
STORAGE INHIBIT FROM S2-B, POS. 3
10 MC TUNE
5MC TUNE
1MC TUNE AMPLITUDE ADJUST
FREQUENCY ADJUST
1MC IN/OUT
B OPTION OSC Y101
FREQ ADJ
F1 1.5A SLO BLO
F2 1.5A SLO BLO
117 VAC
S7 POWER
B1 FAN
I1 GATE
I2
S8 RESET
DISPLAY
J1-12 To T9
J1-13 To T10
J1-14 To T11
J1-15 To T12
J1-16 To R18
J1-17 To S2-A SWINGER
J1-L,Z6 HETERODYNE OUTPUT
J1-11 A,A' INPUT
J1-45 NPN RESET
J1-44 PNP RESET
J1-43 CONTROL GATE INPUT
J1-42 END OF COUNT
J1-36 A OUTPUT
J1-30 'B OUTPUT
J1-38 A' OUTPUT
J1-25,50 10 MC HETERODYNE
J1-4 1 MC
J1-46 TIME BASE OUT
J1-21 TIME BASE IN
J1-31 +30 v
J1-32 -30 v
J1-35 + 6 v
J1-38 - 6 v
J1-3 1 KC
J1-23
J1-48 117 VAC
J1-20 + 20 v
J1-15 - 15 v
J1-7 + 225
J1-- 16,24,28,29 34,40,41,49
A INPUT
B INPUT
A' INPUT
CONTROL GATE INPUT
EOC/STORAGE SIG
START
STOP
x10 OUTPUT
x10 INPUT
x100 INPUT
x100 OUTPUT
1 SEC INHIBIT
COUNT HOLD
PNP RESET LINE
NPN RESET LINE
STORAGE LINE
GATE LAMP CONTROL
STORAGE INHIBIT J101-J FOR COUNT & HOLD
T.B OUT J2
1MC
TIME BASE
INT
EXT
S1-A TEST RATE COUNT HOLD TIME B-A PER A PER ×10 PER ×100 RAT ☐ ☐ RAT ×10 GATE ☐ ☐ 10 J1-A
S1-B S1-C S1-D S1-E S1-F
S2-A S2-B S2-C S2-D S2-E S2-F S2-G
S3 S4 S5 S6 S8 S9 S10 RANGE
R4, 5K LEVEL
R5 10K 1/4W
R6 10K 1/4W
R7 1.5K 1/4W
R8 1K
R9 470Ω 1/2W
R10 1K 1W
R11 270Ω 1/2W
R12 1K
R13 1.5K 1/4W
R14 1K
R15 100K
R16 270Ω 1/2W
R17 270Ω 1/2W
R18 270Ω 1/2W
R19 1K, 2W
R23, 470
C1 .01 1KV
C2 1μF 600V
C3 .05
C4 .05
C5 .01μF
C6 .01
C7 .01μF
C8 .01 MFD 400 VDC
J1-A J1-B J1-C J1-D J1-E J1-F J1-H J1-J J1-K J1-L J1-M J1-N J1-P J1-R J1-S J1-T J1-U J1-V J1-W J1-X J1-Y J1-Z
J2 J3 J5 J8
J101-A J101-C J101-D J101-E J101-F J101-H J101-J
J200-C J200-D J200-E J200-F J200-G J200-H J200-J J200-K J200-L J200-M J200-N J200-P J200-R J200-S J200-T J200-U J200-V J200-W J200-X J200-Y J200-Z
J300-A J300-B J300-C J300-D J300-E J300-F J300-G J300-H J300-J J300-K J300-L J300-M J300-N J300-P J300-R J300-S J300-T J300-U J300-V J300-W J300-X J300-Y J300-Z
J400-A J400-B J400-C J400-D J400-E J400-F J400-G J400-H J400-J J400-K J400-L J400-M J400-N J400-P J400-R J400-S J400-T J400-U J400-V J400-W J400-X J400-Y J400-Z
J800-A J800-B J800-C J800-D J800-E J800-F J800-G J800-H J800-J J800-K J800-L J800-M J800-N J800-P J800-R J800-S J800-T J800-U J800-V J800-W J800-X J800-Y J800-Z
J801-A J801-B J801-C J801-D J801-E J801-F J801-G J801-H J801-J J801-K J801-L J801-M J801-N J801-P J801-R J801-S J801-T J801-U J801-V J801-W J801-X J801-Y J801-Z
J802-A J802-B J802-C J802-D J802-E J802-F J802-G J802-H J802-J J802-K J802-L J802-M J802-N J802-P J802-R J802-S J802-T J802-U J802-V J802-W J802-X J802-Y J802-Z
J1001-A J1001-B J1001-C J1001-D J1001-E J1001-F J1001-G J1001-H J1001-J J1001-K J1001-L J1001-M J1001-N J1001-P J1001-R J1001-S J1001-T J1001-U J1001-V J1001-W J1001-X J1001-Y J1001-Z
T1-1 T1-2 T1-3 T1-4
+225V +45V +30V +6V -6V -30V +100V
SCHEMATIC / ASSEMBLY TABULATION
STANDARD UNIT
B OPTION
D OPTION
D1 OPTION
D2 OPTION
SCHEM
ASS'Y
ADDITIONAL OPTION INFORMATION
100MC AMP COUNTER
POWER SUPPLY
MULT.
MULT. ÷3
TIME BASE
DISPLAY & RESET
10 MC READOUT
10MC DECADE
2.5MC DECADE
250KC DECADE
17992
17995
15413
15414
15415
15416
17970
17966
17597
17596
15422
15423
19244
19243
19229
19228
15201
15200
11528
11527
626
11523

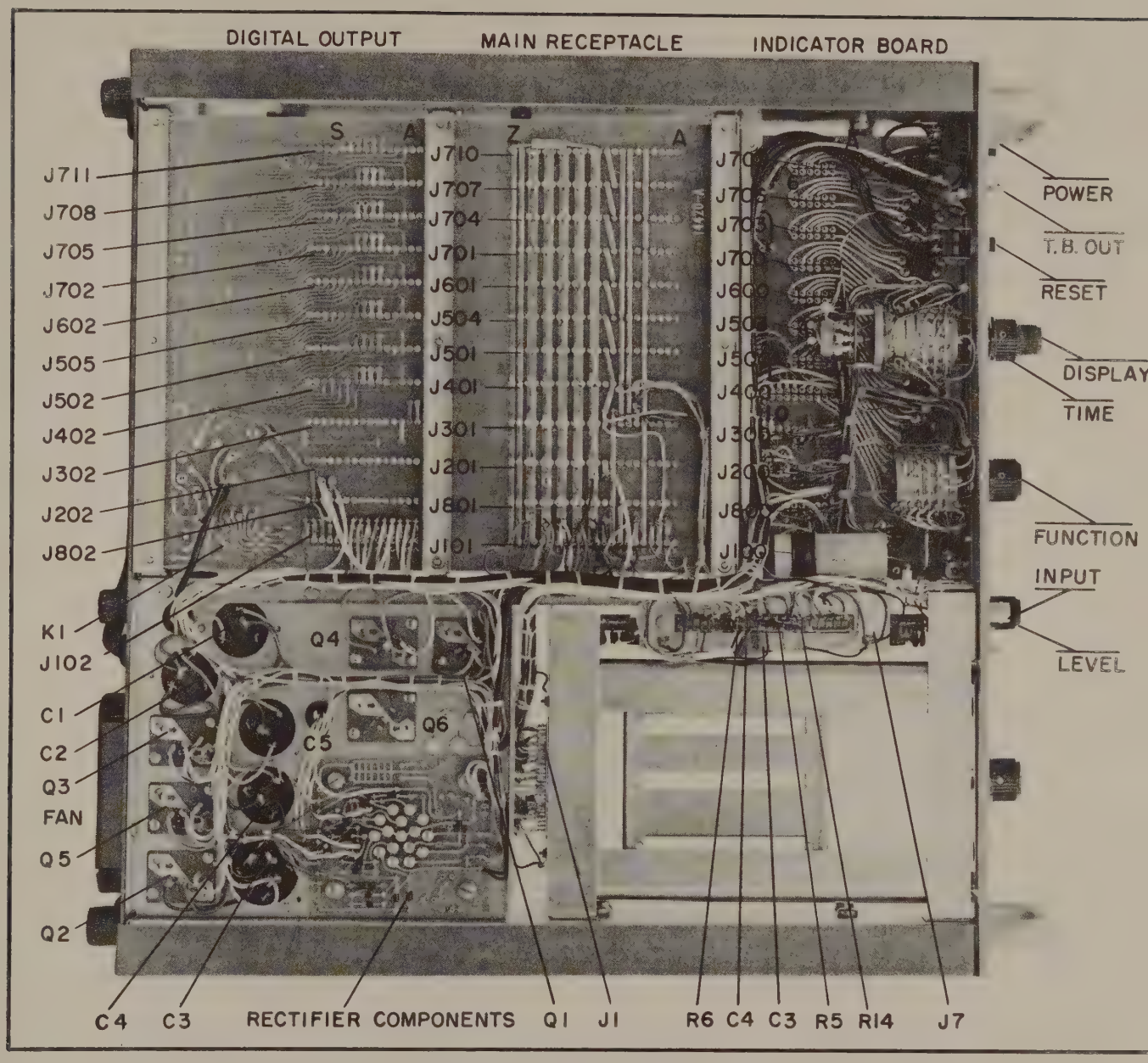


Figure 4-3 Bottom View of Model 1037 Counter

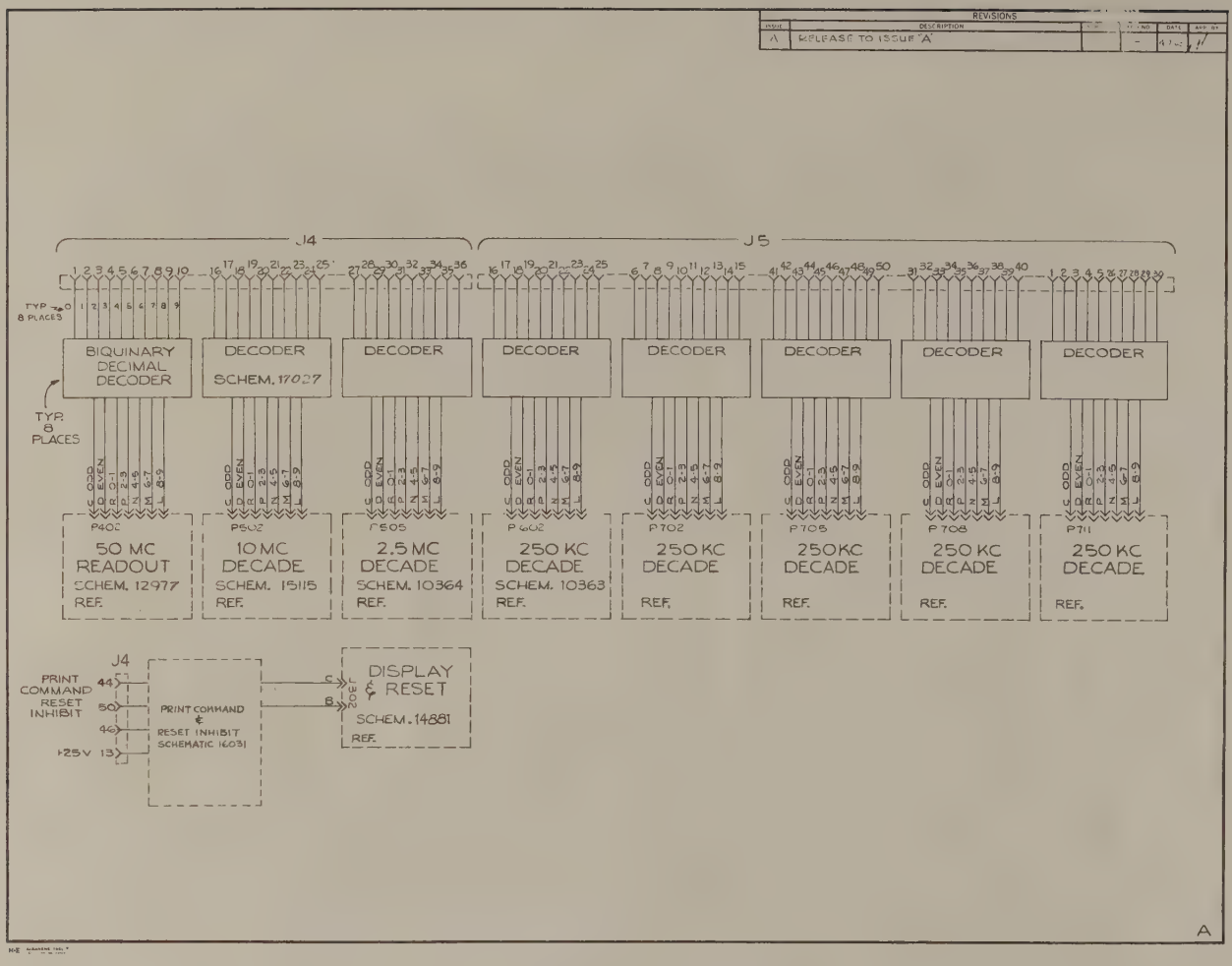


Figure 4-4 D Option Schematic No. 15683

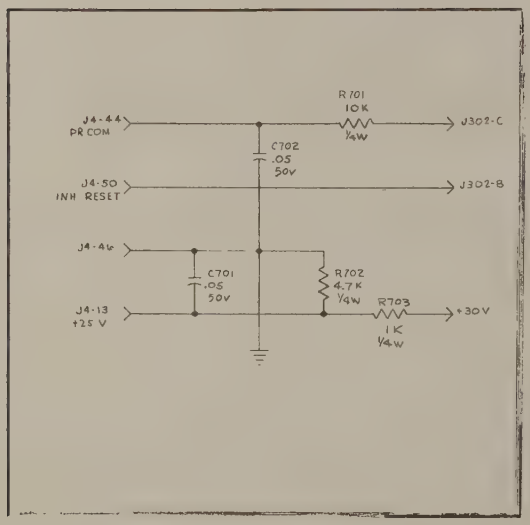


Figure 4-5 D Option Print Command Inhibit Reset Schematic No. 16031

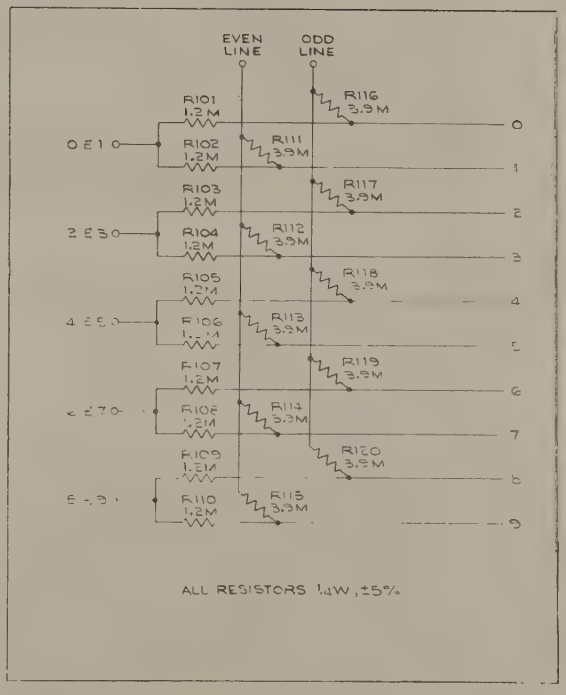
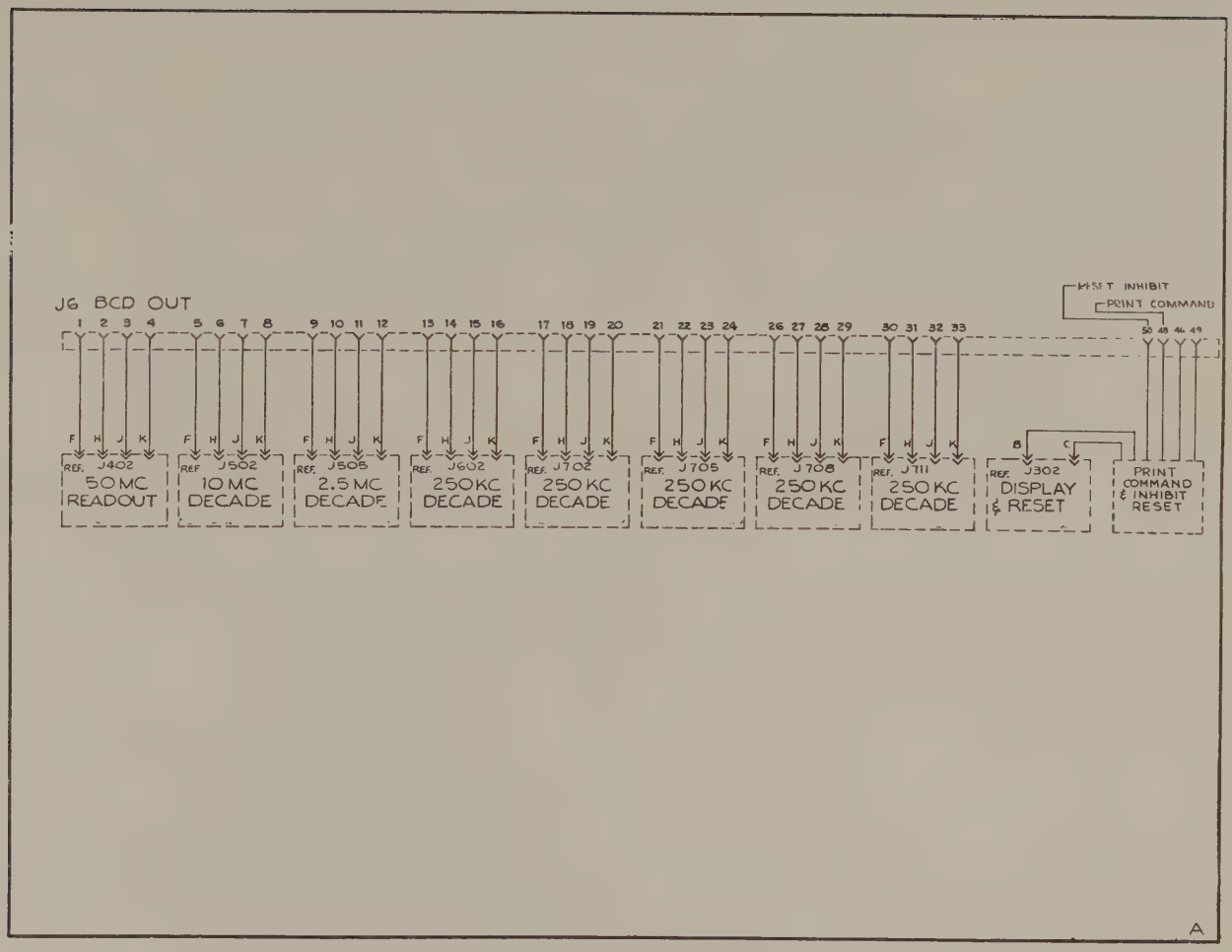
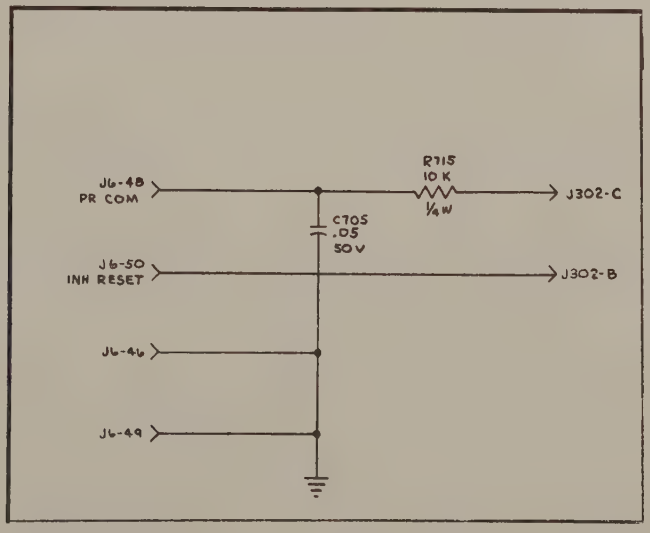


Figure 4-6 D Option BCD to 10 Line Decoder No. 17027



1–2–4–8 Digital Output



Print Command Inhibit Reset Schematic No. 16032

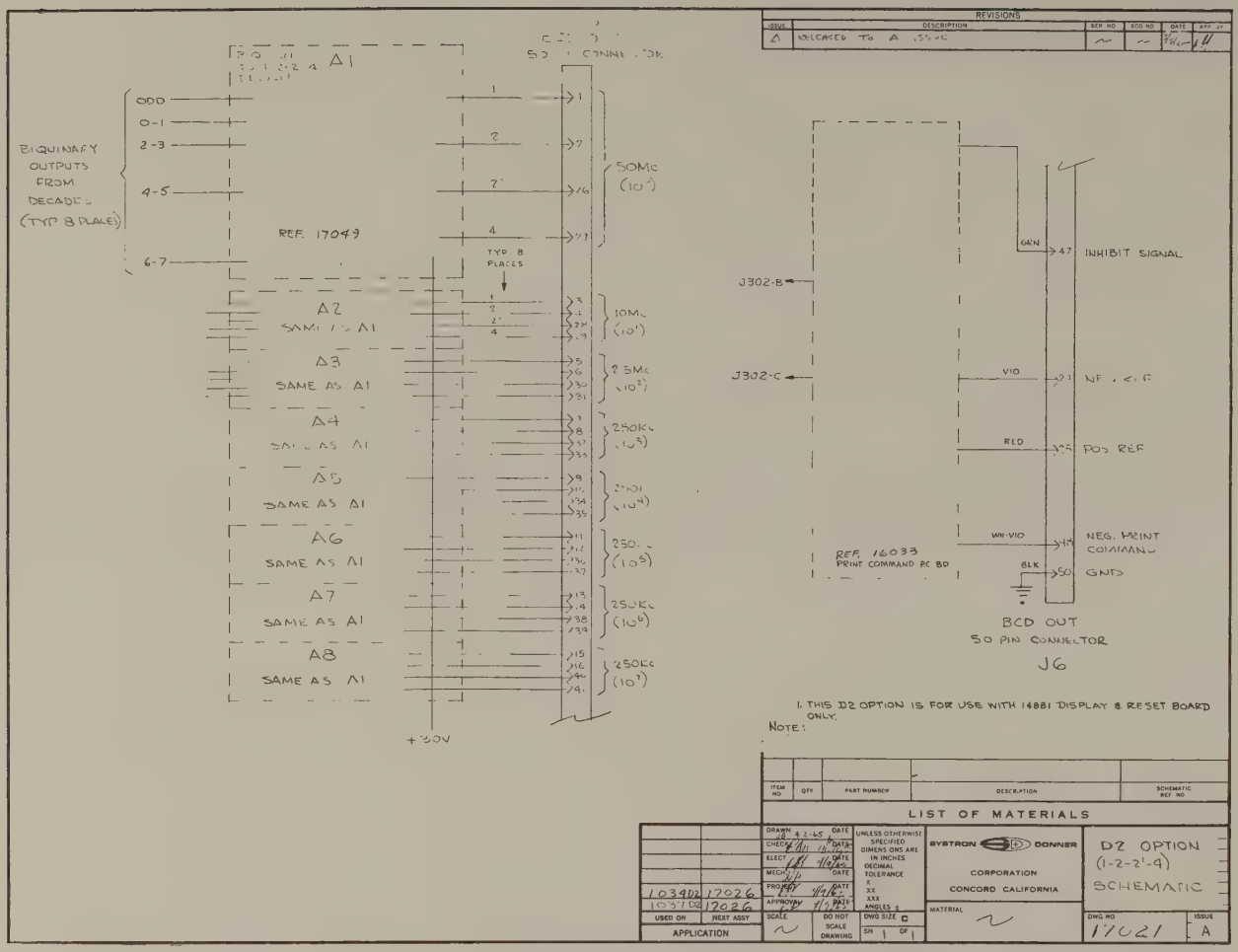


Figure 4-9 D2 Option Schematic No. 17021

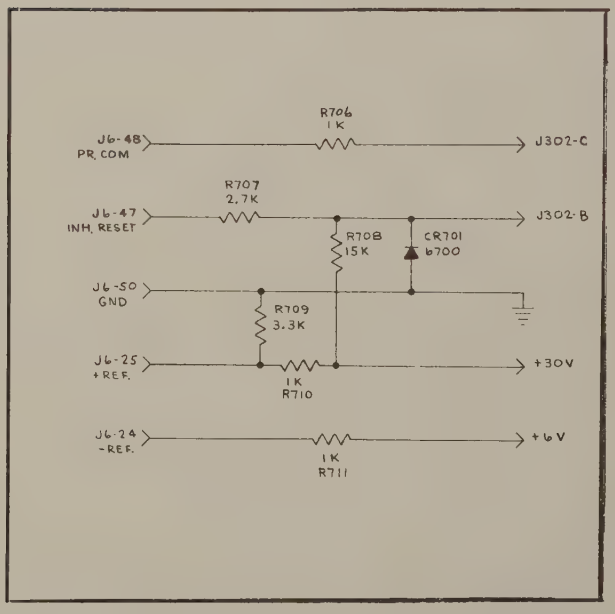


Figure 4-10 D2 Option Print Command Inhibit Reset Schematic No. 16033

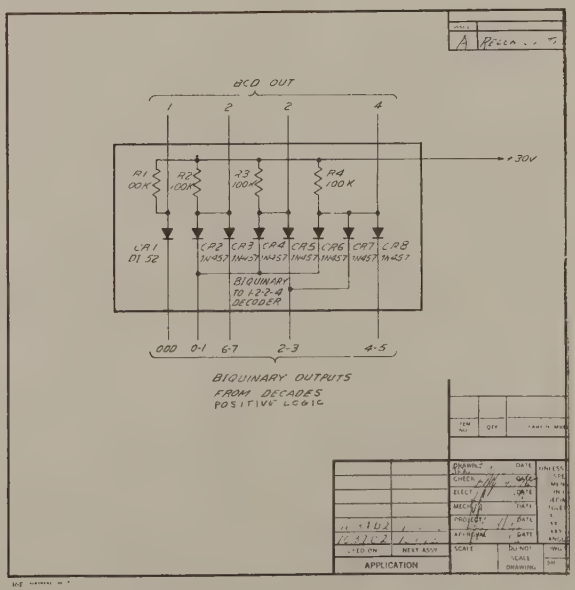


Figure 4-11 D2 Option Bi-Quinary to 1–2–2–4 Conversion No. 17049

Table 4-3 Model 1037 Counter Assembly Parts List

Part Number	Description	Ref.
15452	**FINAL ASSEMBLY**	
15439	Panel, Front, Assembly	
15440	Panel, Front S.S. Assy	
15962	Time Base-Function Sw. Cable Assy	
15963	Time Base Sw. Jumper & Loose Wire Assembly	
15961	Wire Prep. Assy	
15964	Function Sw. Jumper & Loose Wire Assembly	
17004	Wire Prep Assy	
17002	Mother Bd #1 PC Bd Assy	
16155	Loose Wire Prep. Assy	
15459	Annunciator Assy	
15718	Range Sw-Level Control Cable Assy	
15455	Rear Panel Assy	
15448	Power Supply Assy	
15965	Connector J1 Cable Assy	
15966	Wire Prep Assy	
15412	Power Supply PC Bd Assy	
15458	Mother Bd #2 PC Bd Assy	
15394	Chassis Assembly	
16152	Connector J7 Cable Assy	
16151	Wire Prep Assy	
10504	250KC Stand. Decade PC Bd Assy	
13269	2.5MC Stand. Decade PC Bd Assy	
15116	10MC Stand. Decade PC Bd Assy	
12242	50MC Readout Decade PC Bd Assy	
15391	Display & Reset PC Bd Assy	
11095	Multiplier & Osc. PC Bd Assy	
13534	50MC Amplifier PC Bd Assy	
15422	Time Base PC Bd Assy	
11523	250KC Storage Decade PC Bd Assy	
11527	2.5MC Storage Decade PC Bd Assy	
15200	10MC Storage Decade PC Bd Assy	
12979	50MC Readout Decade PC Bd Assy	
12983	Multiply ÷ 3 PC Bd Assy	
12970	Power Supply PC Bd Assy	
15439	**FRONT PANEL ASSEMBLY**	
15440	Panel, Front, S.S. Assy	
15581	Art Work	
15415	Panel Front	
17007	Panel Front Blank	
15962	Time Base-Function Sw. Cable Assy	
15963	Time Base Sw. Jumper & Loose Wire Assy	
15213	Time Base Sw	S1
15961	Wire Prep Assy	
16141	Wire PVC, per Std Wire List	
15964	Function Sw. Jumper & Loose Wire Assy	
15214	Function Switch	S2
17004	Wire Prep Assy	
16141	Wire #22 PVC per Std. Wire, Coax RG-196/U	
H0955	Ferrule	
TS0024	Thermal Sleeving	
H1104	Cable Tie	
16155	Loose Wire Prep Assy	
15459	Annunciator Assy	
15718	Range Sw-Level Control Cable	
E0137	Lug, Ground, BNC Type	
11342	Lock, Panel	
13548	Knob, Black, 1/4" dia. shaft	
13547	Knob, Black, 1/8" dia. shaft	
J0260	Connector, BNC	J2
S0073	Switth, Toggle, DPDT	S7
S0140	Switch, Pushbutton SPST	S8
11637	Knob Spec. Dual Control	
11636	Knob Spec. Single Shaft	
15404	Bracket, Window	
11066	Window	
15405	Bracket, PC Mtg	
I0055	Lamp, Pilot w/33K 1/4 W Res. Amber	I1
I0047	Lamp, Pilot 3/150K 1/2 W Res. Red	I2
H1271	Screw, Tapping #2x1/4" Type B	
H0988	Screw, Flat Hd. 6-32x1/2 Ph NPS	
H1282	Washer, Lock #4 Int Tooth CPS	
H1273	Screw Pan Hd 4-40x5/16 Ph CPS	
H0984	Screw Pan Hd 6-32x3/8 Ph CPS	
H0410	Washer, Lock #6 Int Tooth CPS	

Part Number	Description	Ref.
17002	**MOTHER BOARD NO. 1 P. C. ASSEMBLY**	
16160	Mother Bd #1 PC Board	
17000	Artwork Mother Bd #1	
16046	Insulator, Socket	
E0100	Terminal	
X0078	Socket, 9 Contacts	
J0262	Connector, 20 Contacts	
13550	Connector, 12 Contacts	
I0052	Indicator	I8
	↕	I9
		I10
		I11
	Same as I8	I12
R1665	Potentiometer 5K, ±30% 1/4w	R4
R0677	Resistor, 470Ω 1/2w 5%	R8
R0365	Resistor, 270Ω 1/2w 5%	R16, R17, R18
R1573	Resistor, 1K 2w 5%	R19
R1089	Resistor, 1K 1w 5%	R26, R27
15455	**REAR PANEL ASSEMBLY**	
15658	Panel, Rear SS Assy	
12876	Art work	
15456	Panel, Rear Welding Assy	
15457	Panel, Rear	
H0390	Weld Nut 4-40	
H03969	Weld Nut 6-32	
11115	Screen	
11096	Plug Plate	
H0390	Weld Nut 4-40	
15681	Fan Guard Assy	
15679	Cover, Fan Guard	
15680	Screen, Fan Guard	
15711	Fan Motor & Blade Assy	B1
B0013-1	Fan Motor	
B0013-2	Fan Blade	
B0013-3	Screw 3-48	
15969	Rear Panel Cable Assy	
15970	Wire Prep Assy	
	Wire Belden 8451 Two Cond.	
	Wire, Coax R6-196/U	
	Wire 22 Ga PVC Per Wire Std 16141	
40955	Ferrule	
TS0024	Thermal Sleeving	
H1104	Cable Tie	
W0004	Cord, AC Line	
X0034	Holder, Fuse	
J0260	Connector, BNC	J3
S0110	Switch Slide, DPDT	S4
	Same as S4	S6
E0137	Lug Ground, BNC Type	
H0383	Heyco Nut	
F0019	Fuse 1.5 A Slo Blo	F1
	Same as F1	F2
R1044	Resistor, 470Ω 5% 1/4w	R25
C0562	Capacitor .01 mfd. 50v Disc	C6
H0404	Rivet 1/8 dia 1/8 long	
H0819	Screw, Pan Hd. 4-40x3/4 NPS	
H1049	Screw, Pan Hd. 6-32x1/2 NPS	
H0657	Screw, Pan Hd. 4-40x5/16 NPS	
H0749	Nut, Hex 6-32	
H0410	Washer, Lock #6 Int. Tooth CPS	
H0248	Washer, Lock #4 Int. Tooth NPS	
15458	**MOTHER BOARD NO. 2 P. C. ASSEMBLY**	
16159	Mother Bd #2 PC Board	
17001	Art Work	
X0103	Socket Octal	
J0228	Connector, 22 Contacts	
J0272	Connector, 15 Contacts	
E0100	Terminal (22 Ga Wire)	
E0191	Terminal (18 Ga Wire)	
R0739	Resistor, 10Ω 5% 1/4w	R1
R0136	Resistor, 3.3K 5% 1/2w	R14
C0424	Capacitor, .001 mfd 500v Disc	C1
C0441	Capacitor, .01 mfd	C8

Table 4-3 (Con't)

Part Number	Description	Ref.
15459	ANNUNCIATOR ASSEMBLY	
14421	Base, Annunciator	
15474	Plate, Socket, Annunciator	
15475	Spacer, Annunciator	
X0133	Socket, Lamp Eldema 2K	
I0058	Lamp, Eldema CF02-WTS-1762	I2
		I3
		I4
		I5
		I6
	Same as I2	I7
H0549	Screw, Mach. 4-40x1 Bd. Hd	
H0248	Washer, Int. Tooth, #4 N1. Pl. St.	
15572	Light Diffuser S.S. Assy	
14414	Art Work	
14608	Light Diffuser Annunciator	
15394	CHASSIS ASSEMBLY	
16152	Connector J7 Cable Assy	
16151	Wire Prep Assy	
H0955	Ferrule	
TS0024	Thermal Sleeving	
	Wire, Coax, RG196/U	
16141	PVC Wire per Std. Wire List	
H1104	Cable Tie	
J0248	Connector 44 Pin	J7
C0708	Capacitor, .05 mfd Disc	C3
	Same as C3	C4
R0939	Resistor, 3.9K 5% 1/4w	R5
	Same as R5	R6
R0966	Resistor, 100Ω 5% 1/4w	R15
15677	CRYSTAL OVEN	
V0105	Indicator, Read Out	V1
		V2
		V3
		V4
		V5
		V6
		V7
	Same as V1	V8
H0265	Feet, Rubber	
S0110	Switch, Slide DPDT	S9
C0801	Capacitor 1MFD 600v	C2
J0260	Connector BNC	J8
H0947	Handle	
E0015	Terminal, Feed Thru	
15841	Cover, Top	
13519	Cover, Bottom	
14733	Cover, Side	
15959	Name Plate	
H0982	Screw, Pan Hd 6-32x5/8 Ph. CPS	
H1065	Screw, Pan Hd 4-40x1/2 Ph. CPS	
H1280	Screw, Flat Hd 4-40x3/16 Ph CPS	
H0989	Screw, Pan Hd 6-32x3/8 Ph. NPS	
H1048	Screw Sheet Metal 4-40x1/4 CPS	
H0964	Screw, Oval Hd. 10-32x5/8 NPS	
H1281	Screw, Pan Hd. 6-32x5/16 CPS	
H1278	Screw, Pan Hd. 10-32x1/2Ph. CPS	
H0927	Washer, Slipt #10 Cad. Pl St.	
H0980	Screw, Pan Hd. 4-40x1/4 Ph. CPS	
H1282	Washer, Lock #4 Int. Tooth	
H0734	Washer, Flat #4 CPS	
H0484	Washer, Flat #6 NPS	
H0746	Washer, Lock Int. Tooth #6NPS	
H0865	Washer, Cut #10	
H0642	Washer, Fiber #10	
H1274	Washer, Split #6 6PS	
H0510	Nut, Hex 4-40	
H1268	Clamp, Clip 1" I.D.	
E0137	Lug, Ground BNC Type	
E0193	Lug, Ground Int. Tooth #4	
H0987	Screw, Mach. P.H. #8-32x3/8 P.H.	
H0735	Washer, Flat #8 Cad. Pl. St.	
16051	Brace Chassis	
H1046	Screw, Flat Hd 4-40x3/8 cd. Pl S.	

Part Number	Description	Ref.
15965	CONNECTOR J1 CABLE ASS'Y	J1
J0264	50 Pin Blue Ribbon Connector	
15966	Wire Prep Assy	
16141	Wire, 22 ga PVC per Std Wire list	
	Wire, Coax RG-196/U	
	Wire, Belden 8451 2 Cond.	
H0955	Ferrule	
TS0024	Thermal Sleeving	
H1104	Cable Tie	
H0726	Washer, Flat #2 Cap. P.S.	
H0377	Nut, Nex 2-56	
E0193	Gnd. Lug, Int Tooth #4	
H1275	Screw, Pan Hd 2-56x5/16 CPS	
15412	Power Supply PC Bd Assy	
H0914	Rivet, Pop	
16134	Plate, Right Hand, Assy	
15388	Plate, Right Hand	
H0393	Weld Nut (6-32)	
H0800	Weld Nut (10-32)	
16052	Bracket Mtg. Brace	
H0390	Weld Nut (4-40)	
15409	Plate Center, Assy	
12882	Bracket Connector	
15393	Plate Center	
H0406	Weld Nut (8-32)	
H0393	Weld Nut (6-32)	
H0390	Weld Nut (4-40)	
16052	Bracket Mtg. Brace	
H0390	Weld Nut (4-40)	
15389	Plate, Left Hand	
H0393	Weld Nut (6-32)	
H0800	Weld Nut (10-32)	
15976	Bracket, Slide Rear	
15977	Bracket, Slide Front	
12851	Guide, Plug-in	
12861	Guide Plate, Front, PC Bd.	
12860	Guide Plate, Rear, PC Bd	
15701	Support Brace	
H0390	Weld Nut (4-40)	
13861	Support Brace Mother Bd. #1	
H0390	Weld Nut (4-40)	
13500	Support Brace, Rear	
H0393	Weld Nut (6-32)	
H0390	Weld Nut (4-40)	

Chapter V — 100 MHz INPUT CIRCUITS

Section A — 100 MHz AMPLIFIER AND DECADE

5.1 GENERAL DESCRIPTION

Refer to the Simplified Block Diagram, Figure 5-1.

The 100 MHz Amplifier and Decade (Assembly #17995, schematic #17992) amplifies the input frequency applied to the RATE/PERIOD input of the counter. The amplified input frequency is then shaped and applied to a high frequency decade divider circuit. A gating circuit between the amplifier and decade portions of the assembly controls the length of time that the input frequency is counted.

A second shaping circuit provides an output for use in period measurements when the signal applied to the decade is the time base, rather than the input frequency.

5.2 ATTENUATOR

Refer to Schematic #17992 (Figure 5-6)

The RATE/PERIOD input from J8 is applied to the attenuator through J7-A. It is then fed in parallel to the three range relays (S1 for X1, S2 for X10, S3 for X100) which are energized by the Range switch, S10.

The series circuit consisting of R20 and C2 attenuates the signal in all ranges. In the X10 range, R72 and C15 further attenuate the signal, R73 and C16 attenuate the signal in the X100 range. The capacitor in each of the attenuators is variable and provides a means of compensating the input signal; these capacitors are set to provide the best possible square wave at 10 KHz with a maximum amplitude input signal.

S4, the Het relay, is energized when the range switch (S10) is in the HET position. The input signal in the Het position is not attenuated, but fed from J7-H through S4, directly to the input amplifier. R75 is factory set to provide best possible input sensitivity for the Het input.

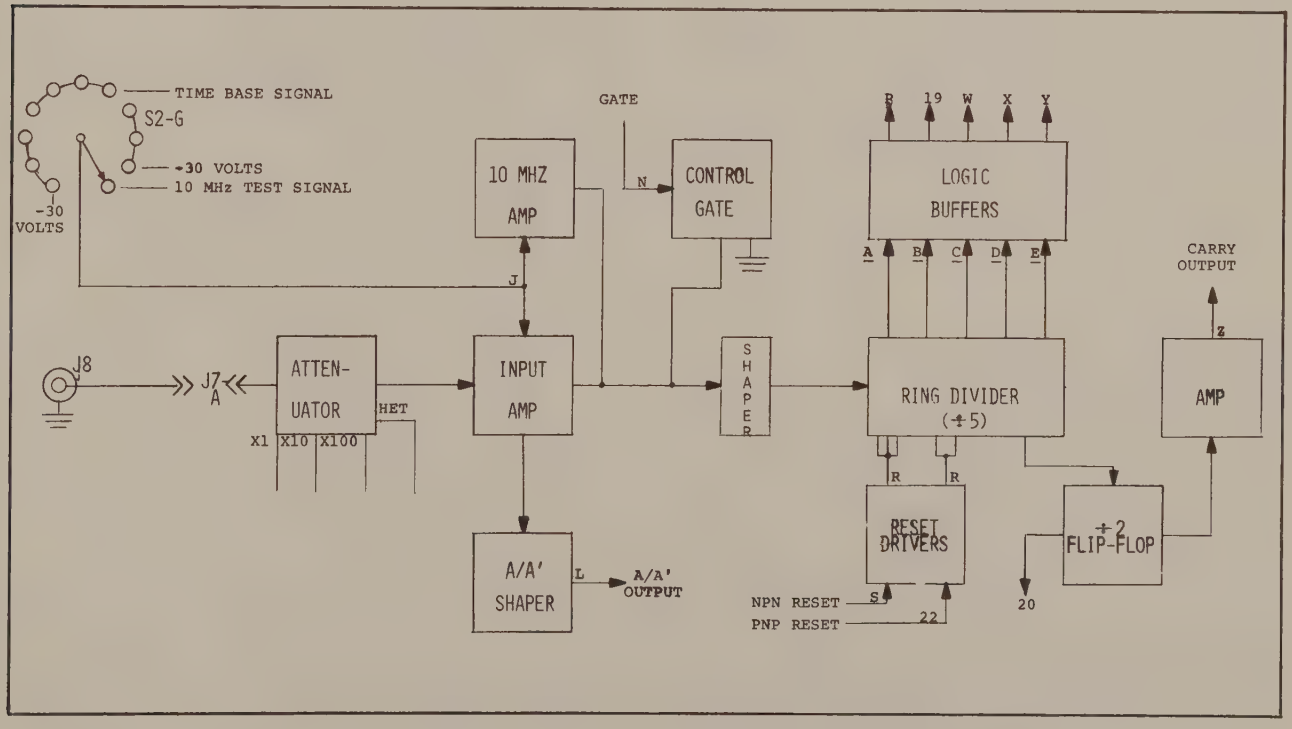


Figure 5-1 Simplified Block Diagram

5.3 INPUT AMPLIFIER

The input amplifier consists of a push-pull emitter coupled stage (Q1, Q2, Q3, and Q4), followed by a temperature compensated common emitter amplifier stage (Q5 and Q6). The circuit receives its input from either the rate/period input (S8, via S1-3 and attenuator R20-62) or from the Het input (J7-H via S4) depending upon the position of the range switch (S10).

Operation of the circuit is as follows: The input is applied to both Q1, a PNP transistor and to Q3, an NPN transistor. Both transistors are biased by the voltage from the Level control (R4) applied through J7-E and R16. This bias determines the point on the input that will trigger the amplifier. Assuming a positive going input, Q1 will begin to conduct less and Q3 will begin to conduct more as the level of the input signal becomes more positive than the bias, causing the signal at the emitters of both transistors to go positive. The positive going output from Q1 will cause Q2, an NPN transistor, to conduct more, resulting in a positive going output at Q2's emitter. At the same time, the positive going output from Q3 will cause Q4, a PNP transistor, to conduct less, resulting in a positive going output at its emitter. As the emitters of Q2 and Q4 are connected, their positive going outputs are additive and are fed to the base of Q5 via R22 and C6. Q5 forms a conventional common emitter amplifier in conjunction with Q6. Q6 is normally saturated by the −30 volt signal from J7-J which, in effect, grounds the emitter of Q5 and allows it to function as an amplifier. Q5 amplifies and inverts its input and applies it to the base of Q9 which is the first stage of the shaper circuit that precedes the ring divider.

5.4 RING DIVIDER CIRCUITS

The ring divider is composed of five identical, cascaded switch stages which collectively divide the incoming signal frequency by five (i.e., each stage runs at one-fifth the frequency of the input signal.) Each stage of the ring provides an output to an associated buffer. These buffers invert and transfer the quinary form logic on 5 lines to the 100 MHz Readout Decoder Board for translation. A sixth output from the ring is fed to the ÷2 Flip-flop to produce a divide by 2 signal (F) which, when considered with its inversion (G) and the quinary logic signals from the logic buffers, combines to form a qui-binary logic signal. The complement output of the ÷2 Flip-flop is utilized as a carry signal to drive the second decade board (10 MHz Board) in the counting chain.

5.4.1 Principles of Operation

The ring divider is brought into the proper set-up condition by the NPN and PNP reset pulses generated in the reset generator circuitry and applied to reset drivers Q33 and Q34, respectively. The reset pulses are inverted and fed to the ring, resetting it to zero. The NPN reset signal is also used to reset the ÷2 Flip-flop via CR22.

The gated input signal is applied to the base of Q9 which is used as a shunt connection. Q9 provides the base drive for Q10 which, with Q11, forms a Schmitt trigger circuit and drives the five stages of the ring in parallel. The parallel base drive to the five ring stages (Q12 and 13, Q14 and 15, Q16 and 17, Q18 and 19, and Q20 and 21) is critical to proper ring operation. It is developed across a voltage divider circuit consisting of zener diode CR2 (V_z = 2.2v ±5%) and resistor R65 (a factory set Rx).

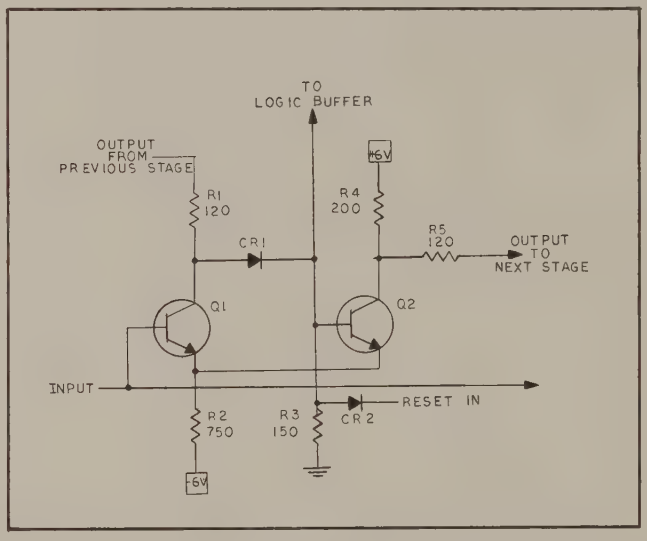


Figure 5-2A Typical Ring Stage

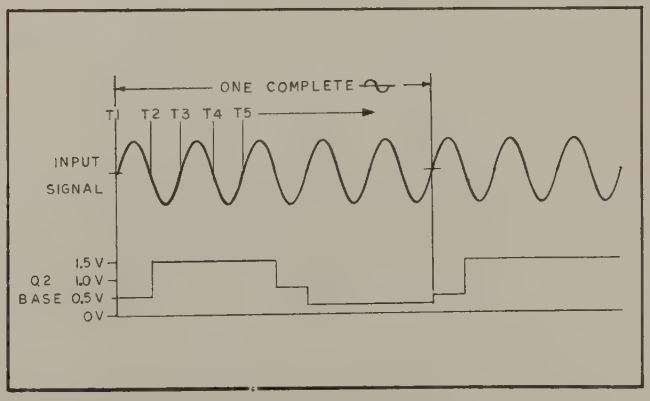


Figure 5-2B Typical Ring Stage Waveforms

Figure 5-2A illustrates a typical stage of the ring. Q1 and Q2 are connected in a Schmitt trigger configuration and, as can be seen from the low resistance values within the circuit, are current-operated devices. Assuming this stage to be the first (or "A") stage of the ring, the level applied to R1 from the previous stage (in this case the fifth [or E] stage of the ring) will be a D.C. level of approximately +2.3v rms. Assuming a static level on the common drive line and the base of Q1, the base of Q2 will be at +0.5 volts rms (Q1 conducting and Q2 off).

NOTE: The voltage and signal levels given in this description are approximations and will vary between stages.

The drive signal amplitude from the ring drive circuit will be 600 millivolts, swinging from +0.3 volts D.C. to +0.9 volts D.C., under optimum conditions. (Minimum drive amplitude for reliable ring operation is 400 millivolts, swinging from +0.5 volts DC to +0.9 volts DC) When this drive signal is applied to the common drive line, Q1 will switch to the off condition with the first negative-going transition, time T2 (refer to Figure 5-2B). The voltage at the anode of CR1 rises to +2.4 volts, causing the base of Q2 to switch to +1.5 volts, and Q2 switches to the on condition. As Q1 conduction decreases, the corresponding voltage change is felt within the Q2 base circuit and Q2 begins to conduct. Conduction of Q2 creates a rising voltage across R2 which drives Q1 further toward the off state. The regenerative effect of the common emitter configuration allows switching times within 3 to 4 nanoseconds.

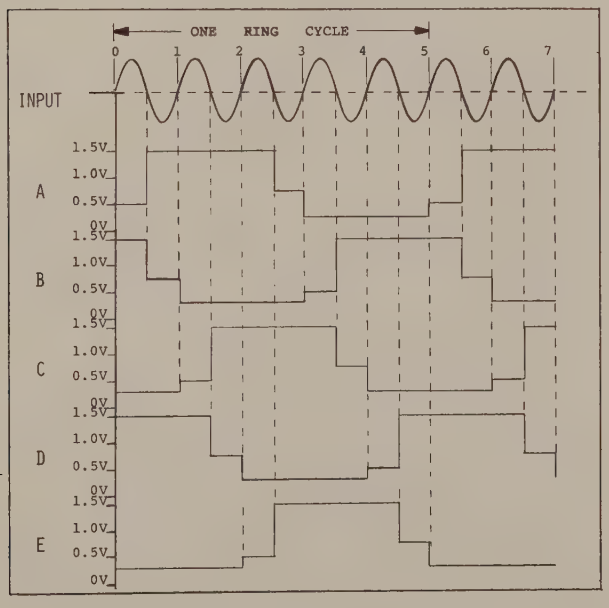


Figure 5-3 Ring Divider Waveforms

The voltage change at the collector of Q2 is coupled through R5 to provide the switching bias to the following stage of the ring. Each stage of the ring switches (in turn) when the proper level of switching bias is applied from the previous stage, and the input signal transits through zero to the level to which its driver transistor can respond (refer to Figure 5-3). The bias level applied to Q1 switches exactly as does the E stage waveform in Figure 5-3. The typical ring stage (in Figure 5-2A) operates in the same manner as the Q12 and Q13 stage of the ring divider in Figure 5-6. Use of Figure 5-3 with Figure 5-2 will provide enough information to readily understand and follow the operation of each ring stage through a complete cycle. Referring to the logic table in Table 5-2, note that the ring returns to the reset condition (A, C, and E stage outputs at logic zero – B and C stage outputs at a logic one), after five complete cycles of input signal. This represents one complete operation of the ring, and after five complete cycles of input, the quinary output repeats the same logic sequence for the second and subsequent groups of five within one selected time base period. The binary outputs (F and G) satisfy the requirement for decoding between the first and second groups (of five) of ring output corresponding to the first and subsequent groups of ten cycles of input.

	Stage						
Input	A	B	C	D	E	F	G
0	0	1	0	1	0	0	1
1	1	0	0	1	0	0	1
2	1	0	1	0	0	0	1
3	0	0	1	0	1	0	1
4	0	1	0	0	1	0	1
5	0	1	0	1	0	1	0
6	1	0	0	1	0	1	0
7	1	0	1	0	0	1	0
8	0	0	1	0	1	1	0
9	0	1	0	0	1	1	0

Table 5-2 Ring Decoding

The four levels observed in the ring waveforms of Figures 5-2B and 5.3 are a unique combination of steady-state switching levels (+1.5 volts and +0.3 volts) and hysteresis generated levels (+0.5 volts and +0.75 volts). The latter are a function of the bias applied to the driver transistor of the stage (from the previous ring stage) which is insufficient to overcome the latching

effect of the hysteresis inherent in the Schmitt trigger configuration. Referring to Figure 5-3, it can be seen that the bias level must cause the stage to switch to either of the hysteresis levels in order for it to respond to the input signal. The hysteresis levels observed within the ring are important to its operation as a divider. The logic buffers in series with the ring outputs do not respond to the hysteresis levels, and consequently these levels are effectively filtered within the buffer circuitry.

This circuit description, when used in conjunction with Figures 5-2 and 5-3, will provide the technician with the necessary level of understanding of basic circuit operation to effect repairs. The principles described here apply directly to the ring divider circuits used in the 100 MHz Amplifier and Decade Board, Schematic #17992 (Figure 5-6).

5.5 TROUBLESHOOTING

When a failure is experienced and the cause is localized to the 100 MHz Amplifier and Decade Assembly (by use of troubleshooting logic Figures in Chapter IV), use the following procedure to locate the defective circuit.

1. With the counter de-energized, remove the 100 MHz Amplifier and Decade board from connector J7 and replace with extender board (Assembly #11331). Insert 100 MHz board into extender and turn counter on.

   NOTE:

   Do not re-insert 100 MHz Board into the Counter if the failure has resulted in one or more fuses being blown or smoke rising from the counter. Visually inspect the board and use an ohmmeter to locate the failure.

2. Isolate the failure using Para. 5-5 and the troubleshooting chart in Figure 5-4; or, if the trouble is traced to the ring divider circuit, follow the procedure given in Para. 5.5.2.

5.5.1

The first step in troubleshooting the 100 MHz board is to determine whether the trouble lies in the amplifier or decade section of the board. If the counter operates properly in any one function, it may be assumed that the trouble is in the amplifier section. The amplifier section of the board contains the attenuator, input amplifier, 10 MHz amplifier, gate, and A-A' shaper circuitry. The decade section of the board contains the ring divider, logic buffer, ÷2 flip-flop, and reset driver circuitry. To determine which section has failed, connect the vertical input of an oscilloscope to the junction of R18 and R23. The waveform at this point should show the input signal gated by the gate signal and be similiar, in porportion and amplitude, to the waveform depicted in Figure 5-5-1. If the proper signal is observed, the trouble lies in the decade section. If the signal is absent, distorted, or reduced in amplitude, the trouble is in the amplifier section. Refer to Figure 5-4A for troubleshooting of the amplifier section or Figure 5-4B for the decade section.

5.5.2

Failures in the ring divider are classed as either low frequency failures or high frequency failures.

The low frequency component of operation is defined as the D.C. switching which occurs at one-fifth the frequency of the input signal. The low frequency failures are caused by the inability of one or more ring divider stages to properly switch (in response to a change in switching bias from the previous stage[s] or hold the proper reset condition. Generally speaking, when this type of failure occurs, it causes improper operation over the entire frequency range of the ring and is independent of the input signal amplitude. The following procedure outlines the steps to be taken in troubleshooting this type of failure.

1. Place the Function Switch in the COUNT position. (If the unit is a Model 1018 Frequency Meter, ground Pin J7-N instead, and place the Function Switch in the RATE position.)

2. Rotate the Level Control to the extreme clockwise position (+). Depress the Reset Switch.

3. Referring to Figure 5-3, Ring Divider Waveforms, check the base of the switching transistor of each stage with a voltmeter or oscilloscope. Each stage should be at the logic level indicated by the zero marker; i.e., stage A (Q12 and 13) has a level of +0.5 volts on the base of Q13, stage B (Q14 and 15) has a level of +1.5 volts on the base of Q15, stage C (Q16 and 17) has a level of +0.3 volts on the base of Q17, etc. If the levels do not coincide with those in Figure 5-3, ensure that each stage is responding to the reset pulse applied to it (generated with the Reset Switch). The reset pulse is sufficient to overcome an incorrect bias level from a previous stage: it will drive the base of the switching transistor approximately 200 millivolts beyond the DC level required for the reset (or zero) condition.

If the levels observed in the zero condition are correct, cycle the ring divider with the Level Control. Rotating the control from the extreme clockwise (+) position to the extreme counter-clockwise (-) position will provide the equivalent of one-half cycle of input. Returning the control to the '+' position will provide another half cycle of input, thus the one condition (Figure 5-3) is reached. Repeat this procedure for one complete cycle of ring operation, and observe each base for the proper level with each half-cycle of input. When an improper level is observed, the effect of the switching bias from the previous stage must be taken into account. Use of a voltmeter will localize the failure to one or two stages. Once the failure is localized, use of an ohmeter will provide the most expedient means of finding the defective component.

A high frequency failure of the ring divider indicates that a component in the ring will not properly respond to the high frequency currents and voltages it must handle. This type of failure is difficult to find and generally requires the use of a sampling oscilloscope – if it is to be located with normal troubleshooting procedures. The most frequent cause of a high frequency failure is a transistor which experiences a change in beta at the higher ring frequencies. The most convenient method for locating the defective transistor is outlined in the following procedure.

1. Increase input frequency to the point where the counter begins to give erroneous readout indications. (Function Switch in RATE position).

2. Using a soldering iron, heat each ring transistor in turn. Place the iron on the case of the transistor (case is grounded) for a few seconds – just to the point where the case is hot to the touch. Allow enough time to see if the readout stabilizes at the correct reading before heating the next transistor.

3. If step 2 does not locate the defective transistor, use an aerosol can of freon to freeze each transistor in turn. Proceed as in step 2 using the freon dispenser instead of the soldering iron.

NOTE:

Other components, mainly diodes and capacitors, will also cause this type of failure. Use of the above procedure will also locate these components when defective.

5.6 ALIGNMENT OF INPUT ATTENUATOR

The adjustments located on the 100 MHz Amplifier and Decade Assembly are factory set. The need for readjustment should arise only when a component has been replaced in the input circuitry, or an adjustment has been inadvertently disturbed.

Table 5-3 Recommended Test Equipment

Item	Manufacturer	Model
Oscilloscope	Tektronix Inc.	545
Plug-in Unit	Tektronix Inc.	Type 82
Square Wave Gen.	Hewlett Packard	211A

5.6.1 Procedure:

1. Place 100 MHz Amplifier and Decade Assembly on extender card. Insert extender card into J7.

2. Attach compensated oscilloscope probe to base of Q1. Turn counter on.

3. Connect square wave generator to the C INPUT, and set frequency of generator to 10 KHz and amplitude to 0.4V peak.

4. Set Function Switch to RATE and Range Switch to 1.

5. Adjust C2 for minimum distortion in the square wave presentation.

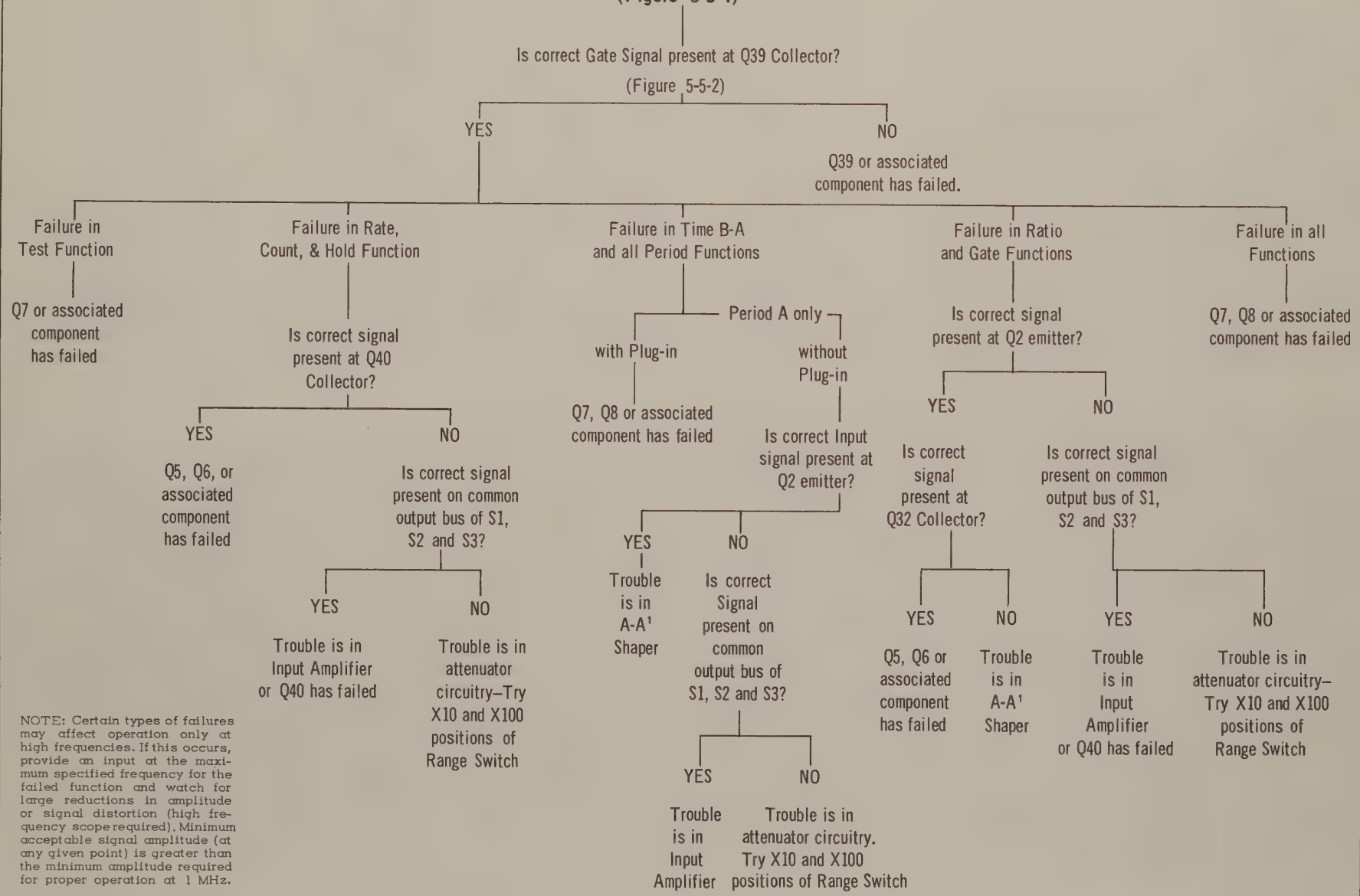
6. Set amplitude of generator to 4.0V peak. Set Range Switch to 10. Adjust C15 for minimum distortion in the square wave presentation.

7. Set amplitude of the generator to 10.0V peak. Set Range Switch to 100. Adjust C16 for minimum distortion in the square wave presentation.

Figure 5-4A AMPLIFIER TROUBLESHOOTING GUIDE

Incorrect Signal at R18–R23 Junction*

(Figure 5-5-1)


Is correct Gate Signal present at Q39 Collector?
(Figure 5-5-2)
YES
NO
Q39 or associated component has failed.
Failure in Test Function
Q7 or associated component has failed
Failure in Rate, Count, & Hold Function
Is correct signal present at Q40 Collector?
YES
Q5, Q6, or associated component has failed
NO
Is correct signal present on common output bus of S1, S2 and S3?
YES
Trouble is in Input Amplifier or Q40 has failed
NO
Trouble is in attenuator circuitry–Try X10 and X100 positions of Range Switch
Failure in Time B-A and all Period Functions
Period A only
with Plug-in
Q7, Q8 or associated component has failed
without Plug-in
Is correct Input signal present at Q2 emitter?
YES
Trouble is in A-A' Shaper
NO
Is correct Signal present on common output bus of S1, S2 and S3?
YES
Trouble is in Input Amplifier
NO
Trouble is in attenuator circuitry. Try X10 and X100 positions of Range Switch
Failure in Ratio and Gate Functions
Is correct signal present at Q2 emitter?
YES
Is correct signal present at Q32 Collector?
YES
Q5, Q6 or associated component has failed
NO
Trouble is in A-A' Shaper
NO
Is correct signal present on common output bus of S1, S2 and S3?
YES
Trouble is in Input Amplifier or Q40 has failed
NO
Trouble is in attenuator circuitry–Try X10 and X100 positions of Range Switch
Failure in all Functions
Q7, Q8 or associated component has failed

NOTE: Certain types of failures may affect operation only at high frequencies. If this occurs, provide an input at the maximum specified frequency for the failed function and watch for large reductions in amplitude or signal distortion (high frequency scope required). Minimum acceptable signal amplitude (at any given point) is greater than the minimum amplitude required for proper operation at 1 MHz.

Figure 5-4B DECADE SECTION TROUBLESHOOTING GUIDE

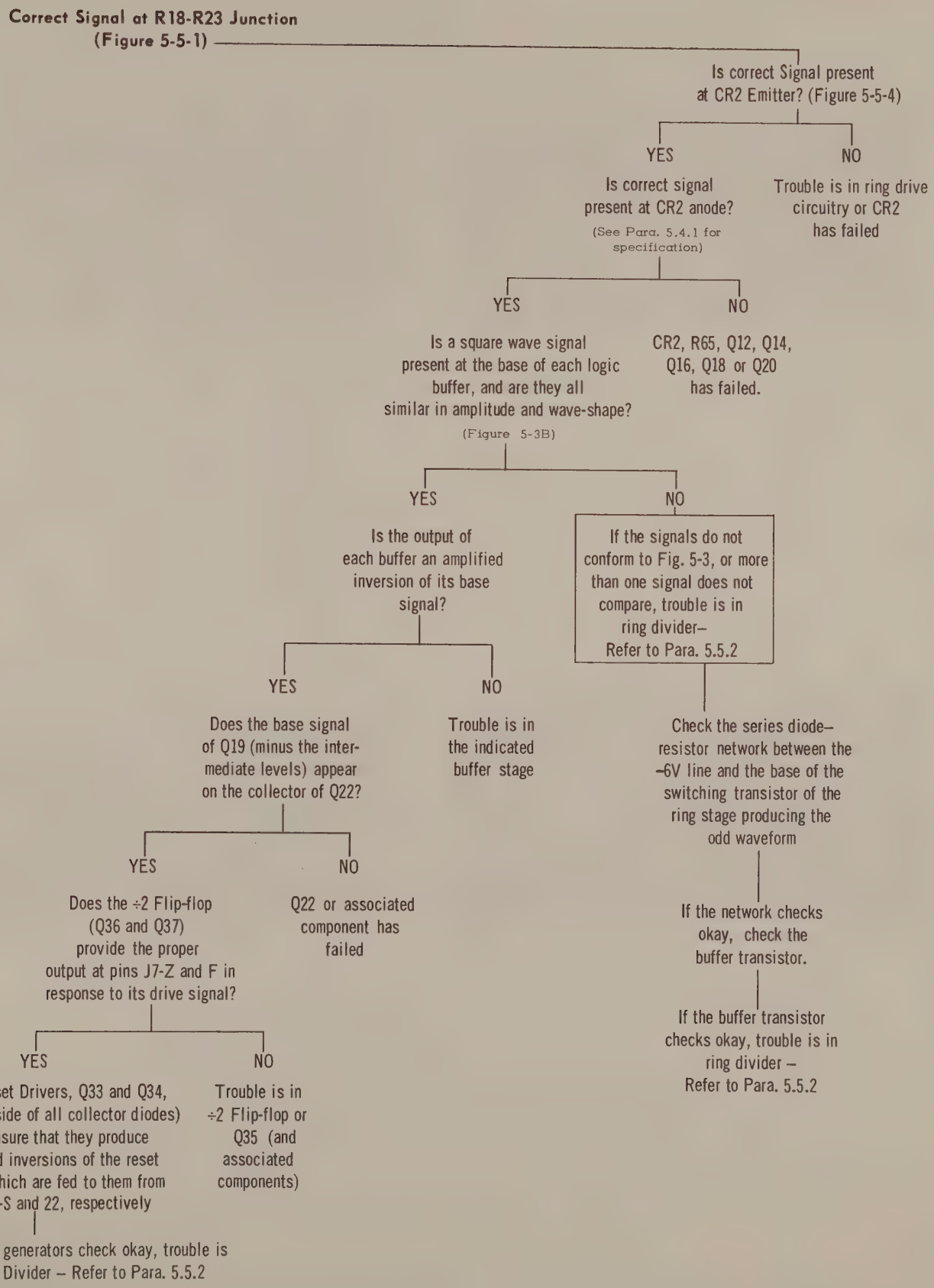
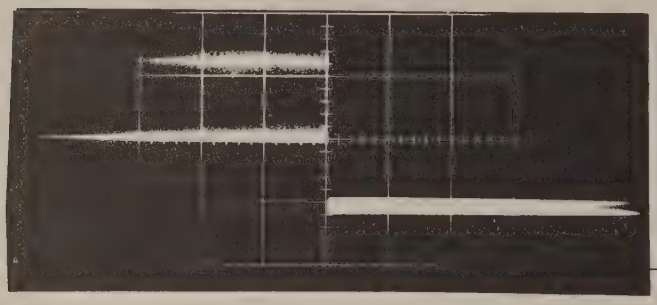

Correct Signal at R18-R23 Junction (Figure 5-5-1)
Is correct Signal present at CR2 Emitter? (Figure 5-5-4)
YES
NO
Trouble is in ring drive circuitry or CR2 has failed
Is correct signal present at CR2 anode? (See Para. 5.4.1 for specification)
YES
NO
CR2, R65, Q12, Q14, Q16, Q18 or Q20 has failed.
Is a square wave signal present at the base of each logic buffer, and are they all similar in amplitude and wave-shape? (Figure 5-3B)
YES
NO
If the signals do not conform to Fig. 5-3, or more than one signal does not compare, trouble is in ring divider– Refer to Para. 5.5.2
Is the output of each buffer an amplified inversion of its base signal?
YES
NO
Trouble is in the indicated buffer stage
Check the series diode–resistor network between the –6V line and the base of the switching transistor of the ring stage producing the odd waveform
If the network checks okay, check the buffer transistor.
If the buffer transistor checks okay, trouble is in ring divider – Refer to Para. 5.5.2
Does the base signal of Q19 (minus the intermediate levels) appear on the collector of Q22?
YES
NO
Q22 or associated component has failed
Does the ÷2 Flip-flop (Q36 and Q37) provide the proper output at pins J7-Z and F in response to its drive signal?
YES
NO
Trouble is in ÷2 Flip-flop or Q35 (and associated components)
Check reset Drivers, Q33 and Q34, (on each side of all collector diodes) and ensure that they produce amplified inversions of the reset pulses which are fed to them from pins J7-S and 22, respectively
If reset generators check okay, trouble is in Ring Divider – Refer to Para. 5.5.2

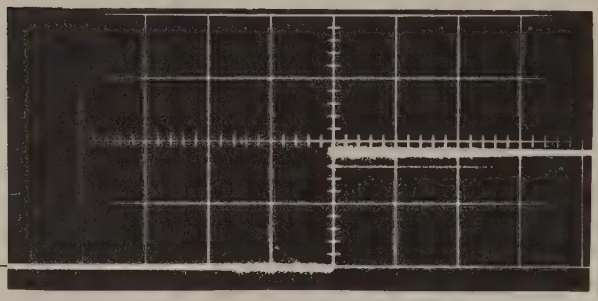
Figure 5-5 100 MHz Amplifier and Decade Waveforms

Figure 5-5-1 Gated Input Signal (R18-23 Junction)



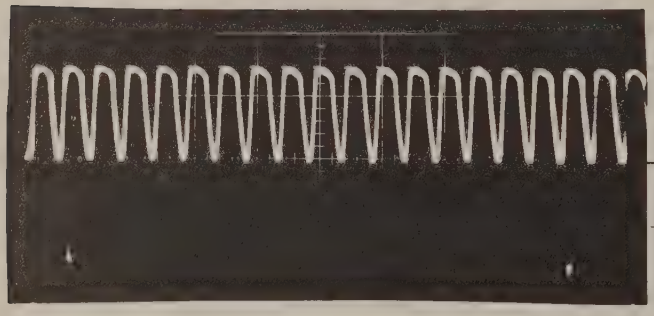
Input:	10 MHz at 100 mv rms
Time Base:	10^{-3}
Function:	Rate
Vertical:	0.2 v/cm
Horizontal:	0.2 ms/cm

Figure 5-5-2 Gate Signal (Q39 Collector)



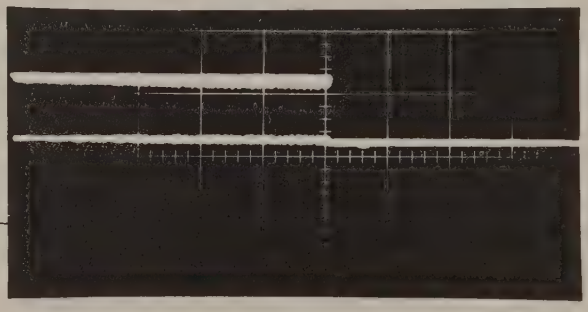
Input:	N.A.
Time Base:	10^{-3}
Function:	Rate
Vertical:	2.0 v/cm
Hortizontal:	0.2 ms/cm

Figure 5-5-3 10 MHz Test Signal (Q7 Base)



Input:	N.A.
Time Base:	N.A.
Function:	Test
Vertical:	0.5 v/cm
Horizontal:	0.2 μs/cm

Figure 5-5-4 Ring Drive Signal (CR2 emitter)



Input:	10 MHz at 100 mv rms
Time Base:	10^{-3}
Function:	Rate
Vertical:	0.5 v/cm
Horizontal:	0.2 ms/cm

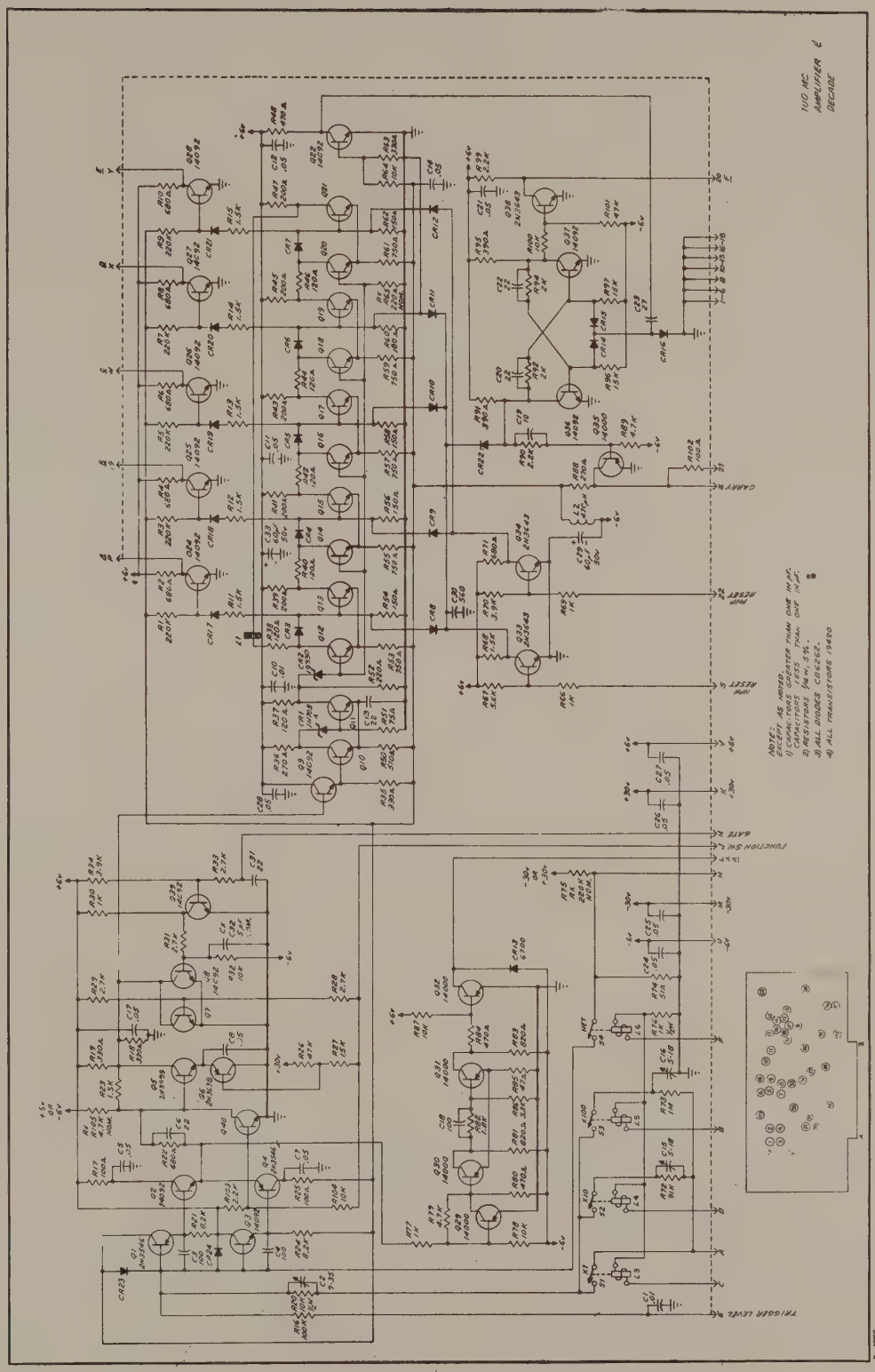


Figure 5-3 100 Mc Amplifier Schematic No. 17992

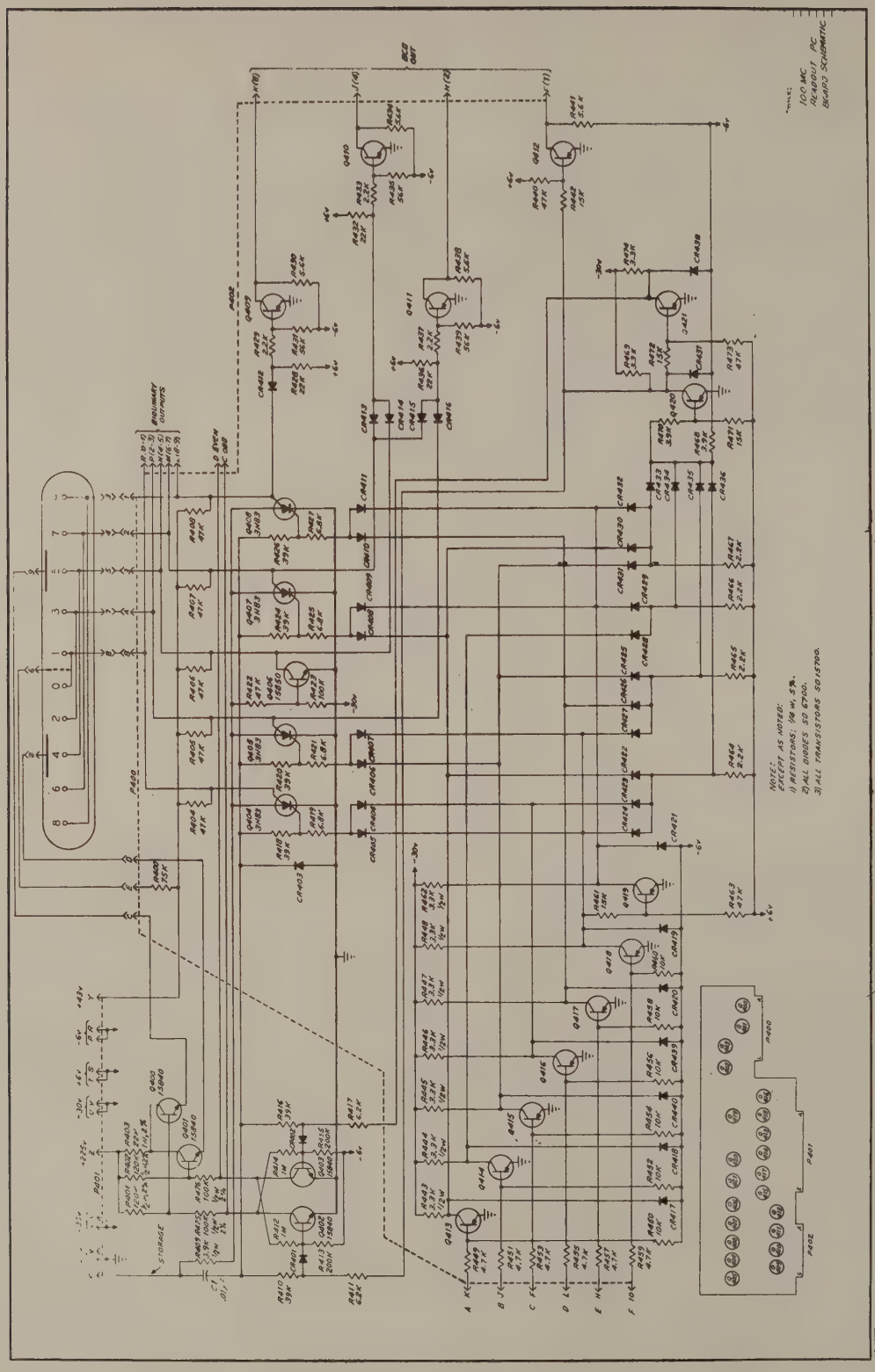


Figure 6-1 100 Mc Readout Schematic No. 19229

5.7 GENERAL

The 100 MHz Readout Decoder board accepts the quibinary logic outputs from the 100 MHz Amplifier and Decoder board and translates them to bi-quinary logic form. The bi-quinary logic is applied to a readout indicator tube, whose dual plates and five dual-cathodes translate the bi-quinary logic to decimal form and display it. The intelligence contained in the signals from the ring divider logic buffers is thus decoded and displayed in decimal form as the least significant digit in the readout indication.

5.8 PRINCIPLES OF OPERATION

Refer to Schematic No. 19229.

Each of the six inputs from the 100 MHz Amplifier and Decade board is fed to the base of a converter transistor which converts the positive true logic of the input (1 = +6V, 0 = 0V) to negative true logic (1 = −6V, 0 = 0V). There is no inversion of the logic signals through these stages; however, the F signal (÷2 flip-flop output) is applied to an inverter transistor (Q419) from the collector of its converter stage (Q418) and becomes the G signal ($\overline{F}$).

The seven negative logic lines are tied to four OR gates (Refer to Figure 5-7). Three of the gates are three-input, and the remaining one is a two-input gate. The common output of these four gates performs a AND function with transistor Q420. The output of Q420 is routed to the "odd" driver (Q402) and inverter Q421 which inverts the signal and feeds the "even" driver (Q403). The "odd" and "even" drivers drive the high-voltage plate drivers (Q400 and Q401). Figure 5-7 illustrates the logic function involved in selecting either the odd or even plate of the readout indicator tube.

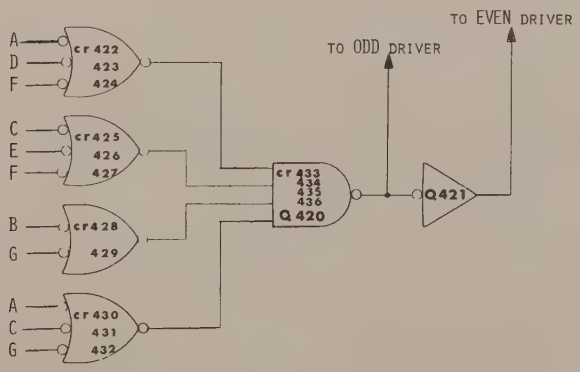


Figure 5-7 Odd/Even Switching Logic

Six of the seven negative logic lines (less B) are connected as inputs to four of the five dual-cathode SCS drivers. The four stages, Q404, 405, 407 and 408 are identical to one another and operate in the same manner. The input to each stage consists of a two-input OR gate connected to the cathode gate of the SCS. When the counter is in the reset condition or no input signal is applied, the inputs to the OR gate in the anode gate circuit of Q404 are all at 0V. This condition allows the SCS to conduct, consequently, grounding the 0-1 cathode and, because the even plate is energized, lighting the 0 indicator. The other cathode driver stages will have at least one input at −6V (logical one) which, by virtue of the OR gate function, will apply to negative voltage at the anode gate and hold the SCS in the off state. When an input signal is applied, the quinary logic signals applied to the OR gate inputs will change with each half cycle of input, causing each SCS stage to turn on for a period of two cycles.

At the time of the fourth and fifth cycles of input frequency, none of the SCS stages will be conducting because all of the input OR gates will have at least one −6V level applied to them. At such time, the +30V level applied to the common SCS anode line (through R409 from Pin P401-E) will cause a positive voltage at the base of Q406. Q406 will turn on and ground the 4-5 cathode, thus providing the proper indication. Figure 5-8 illustrates the logic functions involved in the selection of the proper readout indication.

The potential applied to storage input at Pin P401-E is normally +30V. The generation of the "end of count" signal in other counter circuitry grounds the storage line for a period of several hundred milliseconds. Because the anode leads of the SCS drivers (and the Q406 base circuit voltage divider) are common to this point through R409, the negative-going pulse will turn off any of the driver stages which are conducting. When the storage line returns to +30V, C1 charges to the +30V level creating a positive spike which is applied to the base circuits of the "odd" and "even" drivers and the cathode gate circuits of the SCS drivers. This positive spike will ensure turn on of any of the devices which have the proper quinary logic signals at their control element. It can be seen from the foregoing description that the readout indicator tube will be expectively blanked by the storage reset action. In the storage ON position of S6, the input to Pin P401-E remains at +30V at all times, and the indicator tube will not be blanked.

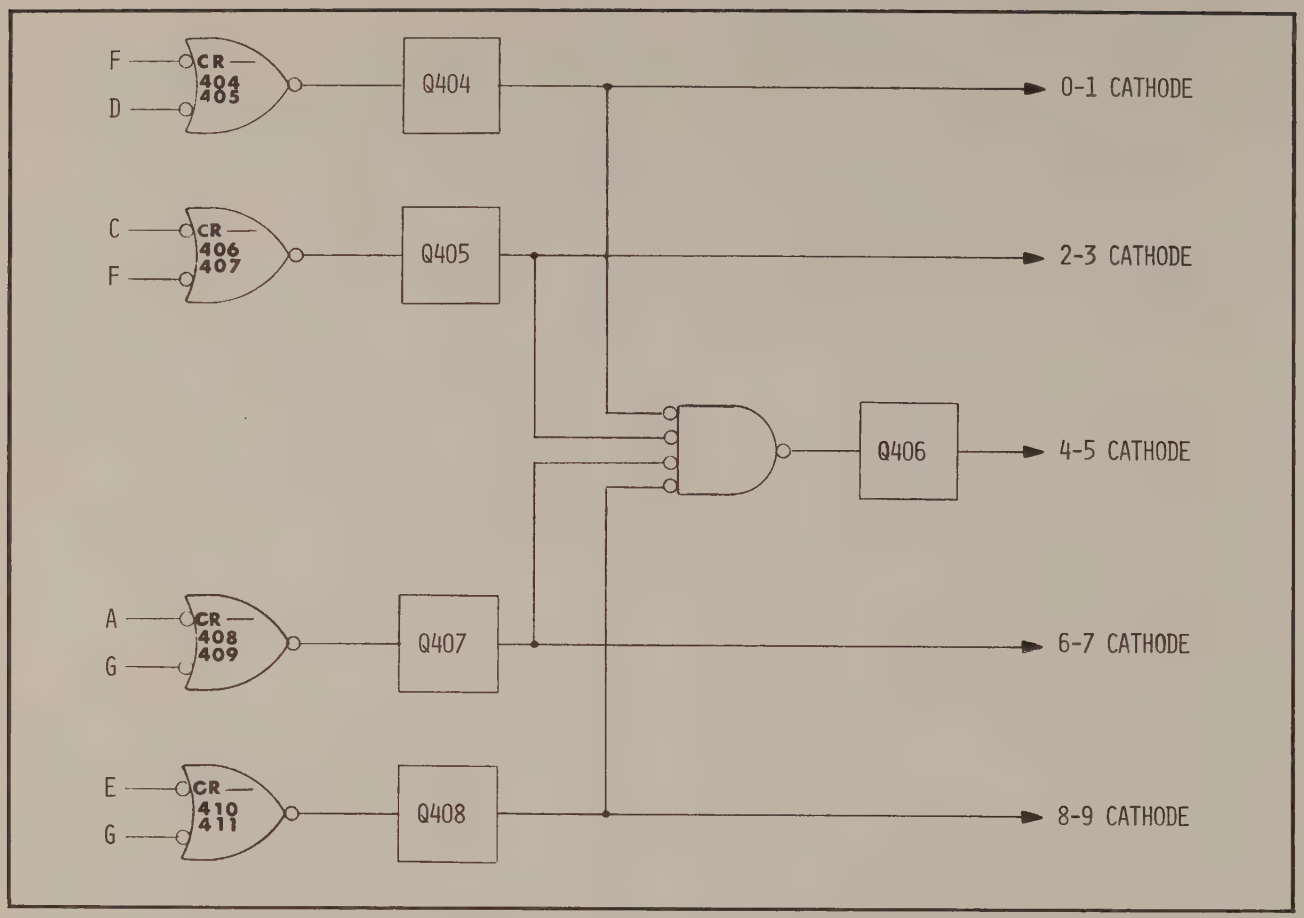


Figure 5-8 Readout Selection Logic

5.9 TROUBLESHOOTING

When a trouble has been traced to the 100 MHz Readout Decoder board, use the following procedure to locate the failed component(s).

1. With the counter turned off, remove the 100 MHz board from its connector and replace with extender boards. Insert 100 MHz board into extenders and turn counter on.

NOTE:
Do not re-insert 100 MHz board into the counter if the failure has resulted in one or more fuses being blown or smoke rising from the counter.

(Refer to Chapter XII, Para. 12-7)

2. Place the Function Switch in the COUNT position. (If the unit is a Model 1018 Frequency Meter, ground Pin J7-N instead, and place the Function Switch in the RATE position.)

3. Rotate the Level Control to the extreme clockwise position (+). Depress the Reset Switch.

4. Observing indicator readout tube V1, cycle the digits from zero to nine by rotating the level control to the extreme counter-clockwise position '–' and back again to the '+' position for each successive digit. Rotating the control from '+' to '–' will provide the equivalent of one-half cycle of input. Returning the control to the '+' position will provide the second half cycle of input for a total of one complete cycle.

5. Utilize the indications from V1 to establish which logic function has been affected by the failure. Table 5-4, Logic Signal Levels, lists the logic signal levels for each cycle of input.

Input	Stage						
	A	B	C	D	E	F	G
0	0	1	0	1	0	0	1
1	1	0	0	1	0	0	1
2	1	0	1	0	0	0	1
3	0	0	1	0	1	0	1
4	0	1	0	0	1	0	1
5	0	1	0	1	0	1	0
6	1	0	0	1	0	1	0
7	1	0	1	0	0	1	0
8	0	0	1	0	1	1	0
9	0	1	0	0	1n	1	0

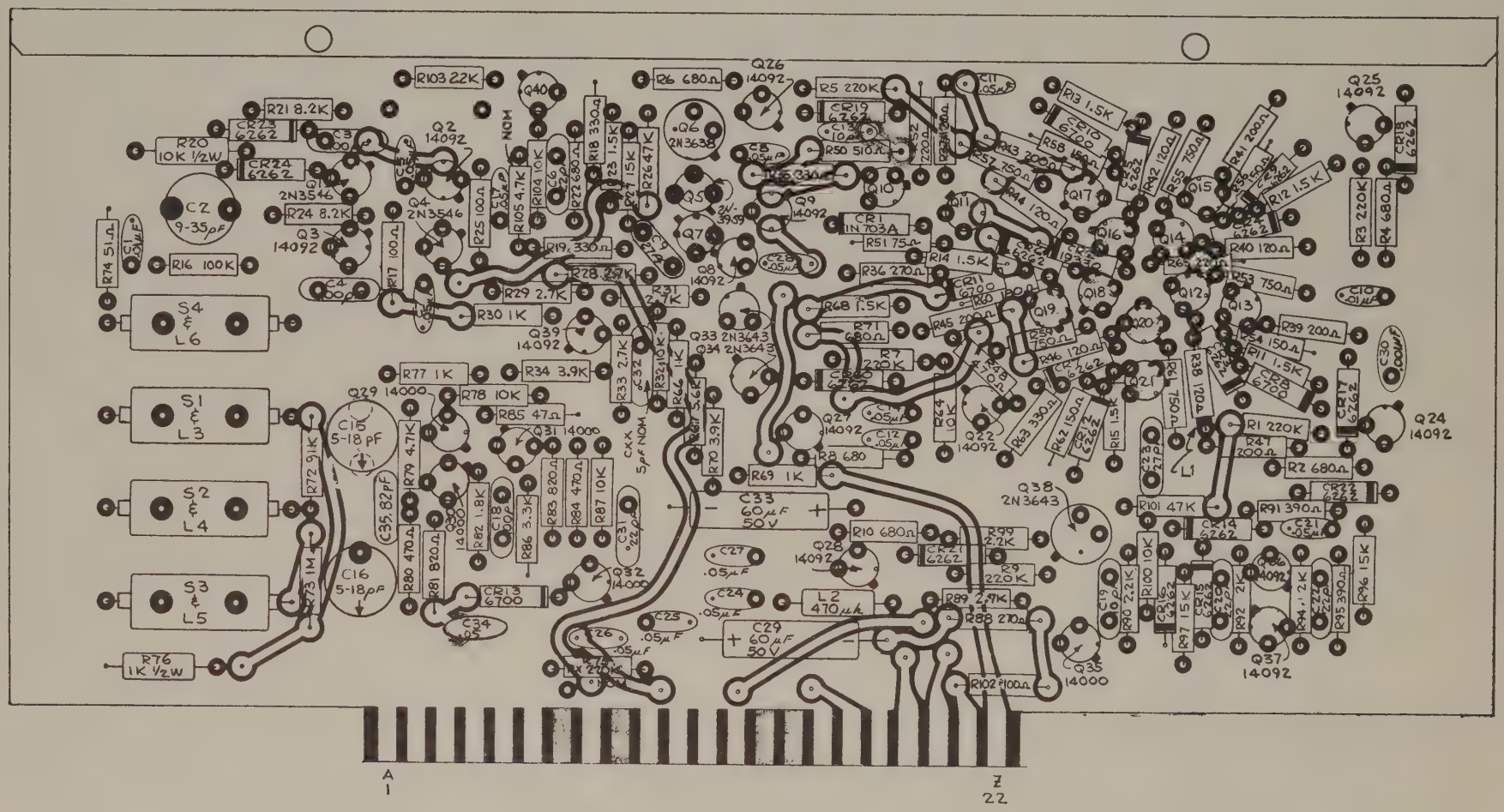
Table 5-4 Logic Signal Levels

TABLE 5-5 PARTS LOCATION - 100 MHz AMP & DECADE

REF DESIG	ILLUS INDEX	SD PART NUMBER	REF DESIG	ILLUS INDEX	SD PART NUMBER	REF DESIG	ILLUS INDEX	SD PART NUMBER
C1	AB1	C0562	Q8	B3	14092	R40	B5	R1461
C2	A1	C0709	Q9	A3	14092	R41	A5	R0736
C3	A2	C0536	Q10	A3	19420	R42	A4	R1461
C4	B2	C0536	Q11	A4	19420	R43	A4	R0736
C5	A2	C0708	Q12	B4	19420	R44	A4	R1461
C6	A2	C0529	Q13	B5	19420	R45	B4	R0736
C7	B2	C0708	Q14	A4	19420	R46	B4	R1461
C8	A3	C0708	Q15	A4-5	19420	R47	B5	R0736
C9	AB3	C0530	Q16	A4	19420	R48	B4	R1044
C10	B5	C0562	Q17	A4	19420	R49	Not Used	-
C11	A4	C0708	Q18	B4	19420	R50	A3	R0984
C12	B3-4	C0708	Q19	B4	19420	R51	AB3-4	R1556
C13	A3	C0527	Q20	B4	19420	R52	A4	R0760
C14	B3-4	C0708	Q21	B4	19420	R53	B5	R1425
C15	BC2	C0712	Q22	B4	19420	R54	B5	R0983
C16	C2	C0712	Q23	Not Used	-	R55	A4	R1425
C17	AB2	C0708	Q24	B5	14092	R56	A5	R0983
C18	B2	C0536	Q25	A5	14092	R57	A4	R1425
C19	C4	C0527	Q26	A3	14092	R58	A4	R0983
C20	C5	C0529	Q27	B3	14092	R59	B4	R1425
C21	C5	C0708	Q28	C3	14092	R60	B4	R0983
C22	C5	C0259	Q29	B2	14000	R61	B4	R1425
C23	B4	C0530	Q30	C2	14000	R62	B4	R0983
C24	C3	C0708	Q31	B2	14000	R63	B4	R0662
C25	C3	C0708	Q32	C2	14000	R64	B4	R0766
C26	C3	C0708	Q33	B3	Q0179	R65	B4-5	R0760
C27	C3	C0708	Q34	B3	Q0179	R66	B3	R0278
C28	B3	C0708	Q35	C4	14000	R67	B3	R0821
C29	C3	C0783	Q36	C5	14092	R68	B3	R0783
C30	C5	C0235	Q37	C5	14092	R69	C3	R0278
C31	C3	C0529	Q38	C4	Q0179	R70	B3	R0939
C32	B3	C0596	Q39	B2	14092	R71	B3	R1234
C33	C3	C0783	Q40	A2	19420	R72	BC2	R1481
C34	C3	C0672	R1	B5	R0967	R73	C2	R0962
C35	C2	C0535	R2	B5	R1234	R74	AB1	R1246
CR1	AB3	CR0264	R3	AB5	R0967	R75	C3	R0967
CR2	B4	19330	R4	AB5	R1234	R76	C1	R0278
CR3	B5	CR0150	R5	A3	R0967	R77	B2	R0278
CR4	A5	CR0150	R6	A3	R1234	R78	B2	R0766
CR5	A4	CR0150	R7	B3-4	R0967	R79	B2	R0892
CR6	B4	CR0150	R8	B3	R1234	R80	C2	R1044
CR7	B4	CR0150	R9	C4	R0967	R81	C2	R0762
CR8	B5	6700	R10	C3-4	R1234	R82	C2	R0959
CR9	A5	CR0150	R11	B5	R0783	R83	C2	R0762
CR10	A4	6700	R12	A5	R0783	R84	C2	R1044
CR11	B4	6700	R13	A4	R0783	R85	B2	R0743
CR12	B4	CR0150	R14	B4	R0783	R86	C2	R0742
CR13	C2	6700	R15	B4	R0783	R87	C2	R0766
CR14	C5	CR0150	R16	B1	R0741	R88	C4	R0694
CR15	C6	CR0150	R17	B2	R0966	R89	C4	R0937
CR16	C5	CR0150	R18	A2	R0662	R90	C4	R0749
CR17	B5	CR0150	R19	B2	R0662	R91	C5	R0880
CR18	A5	CR0150	R20	A1	R0292	R92	C5	R0734
CR19	A3	CR0150	R21	A1	R0883	R93	Not Used	-
CR20	B3	CR0150	R22	A2	R1234	R94	C5	R0734
CR21	C4	CR0150	R23	A3	R0783	R95	C5	R0880
CR22	C5	CR0150	R24	A1-2	R0883	R96	C5	R0728
CR23	A1	CR0150	R25	AB2	R0966	R97	C4	R0728
CR24	A1	CR0150	R26	A3	R0777	R98	Not Used	-
L1	B4-5	H0654	R27	A3	R0728	R99	C4	R0749
L2	C3	L0019	R28	B2-3	R0937	R100	C4	R0766
L3	B1	L0055	R29	B2	R0937	R101	C5	R0777
L4	C1	L0055	R30	B2	R0278	R102	C4	R0966
L5	C1	L0055	R31	B3	R0937	R103	A2	R0749
L6	B1	L0055	R32	B3	R0766	R104	A2	R0766
Q1	A2	Q0192	R33	B3	R0937	R105	AB2	R0892
Q2	A2	14092	R34	B2	R0939	S1	B1	S0132
Q3	B2	14092	R35	A3	R0662	S2	C1	S0132
Q4	B2	Q0192	R36	B3	R0694	S3	C1	S0132
Q5	A3	Q0200	R37	A4	R1461	S4	B1	S0132
Q6	A3	Q0181	R38	B4	R1461			
Q7	B3	19420	R39	B5	R0736			

1 1 2 1 3 1 4 1 5

A
B
C

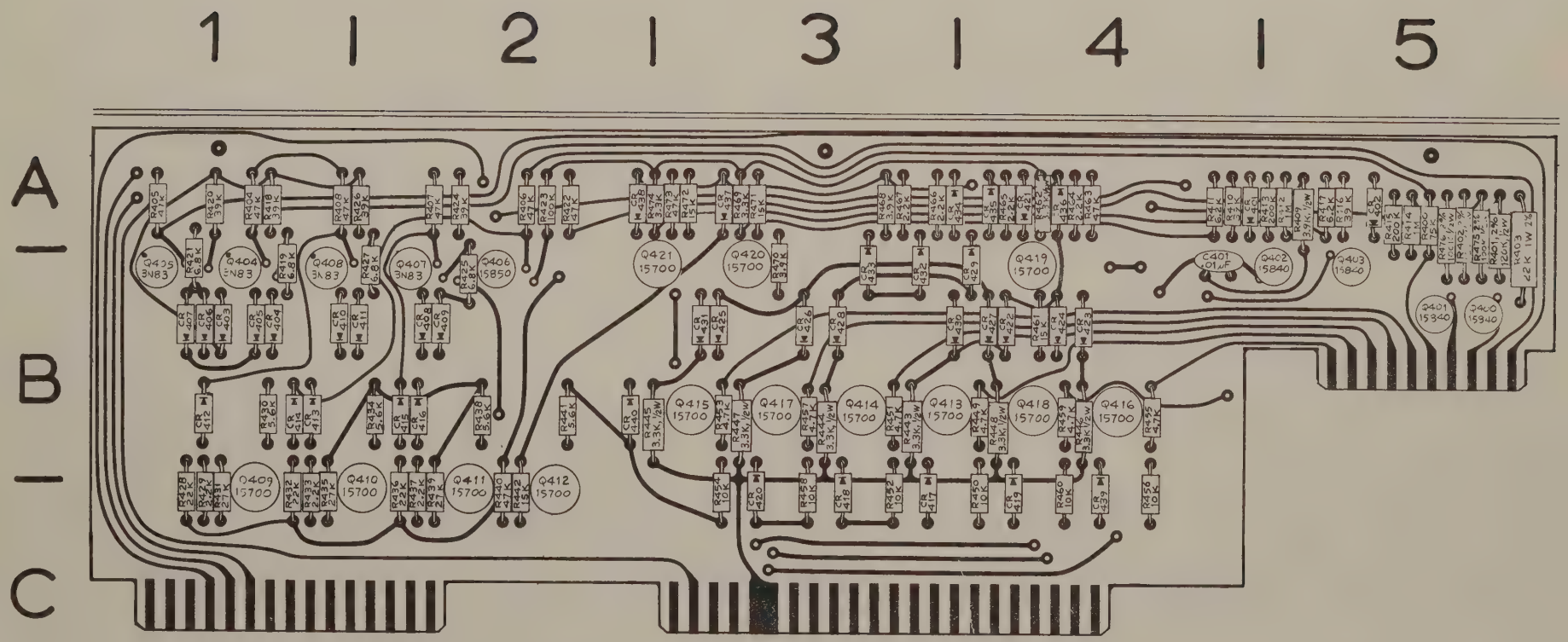


100MHz AMPL & DECADE

5-14

TABLE 5-6 PARTS LOCATION - 100 MHz READOUT-DECODER

REF DESIG	ILLUS INDEX	SD PART NUMBER	REF DESIG	ILLUS INDEX	SD PART NUMBER	REF DESIG	ILLUS INDEX	SD PART NUMBER
C401	A4	C0556	Q406	A2	15840	R431	C1	R0824
CR401	A4	6700	Q407	A2	Q0193	R432	C1	R0768
CR402	A5	6700	Q408	A1	Q0193	R433	C1	R0749
CR403	B1	6700	Q409	C1	15700	R434	B2	R0821
CR404	B1	6700	Q410	C1	15700	R435	C1	R0824
CR405	B1	6700	Q411	C2	15700	R436	C2	R0768
CR406	B1	6700	Q412	C2	15700	R437	C2	R0749
CR407	B1	6700	Q413	B3	15700	R438	B2	R0821
CR408	B1	6700	Q414	B3	15700	R439	C2	R0824
CR409	B1	6700	Q415	B3	15700	R440	C2	R0777
CR410	B1	6700	Q416	B4	15700	R441	B2	R0821
CR411	B1	6700	Q417	B3	15700	R442	C2	R0728
CR412	B1	6700	Q418	B4	15700	R443	B3	R0136
CR413	B1	6700	Q419	A4	15700	R444	B3	R0136
CR414	B1	6700	Q420	B3	15700	R445	B2	R0136
CR415	B2	6700	Q421	A2-3	15700	R446	B4	R0136
CR416	B2	6700	R400	A5	R0976	R447	B3	R0136
CR417	C3	6700	R401	A5	R1499	R448	B4	R0136
CR418	C3	6700	R402	A5	R1499	R449	B4	R0892
CR419	C4	6700	R403	A5	R1596	R450	C4	R0766
CR420	C3	6700	R404	A1	R0777	R451	B3	R0892
CR421	A4	6700	R405	A1	R0777	R452	C3	R0766
CR422	B4	6700	R406	A2	R0777	R453	B3	R0892
CR423	B4	6700	R407	A2	R0777	R454	C3	R0766
CR424	B4	6700	R408	A1	R0777	R455	B4	R0892
CR425	B3	6700	R409	A5	R0616	R456	C4	R0766
CR426	B3	6700	R410	A4	R0748	R457	B3	R0892
CR427	B4	6700	R411	A4	R0965	R458	C3	R0766
CR428	B3	6700	R412	A5	R0962	R459	B4	R0892
CR429	A3	6700	R413	A4	R0823	R460	C4	R0766
CR430	B3	6700	R414	A5	R0962	R461	B4	R0728
CR431	B3	6700	R415	A5	R0823	R462	A4	R0136
CR432	A3	6700	R416	A5	R0748	R463	A4	R0777
CR433	A3	6700	R417	A5	R0965	R464	A4	R0749
CR434	A3	6700	R418	A1	R0748	R465	A4	R0749
CR435	A4	6700	R419	A1	R0696	R466	A3	R0749
CR436	A4	6700	R420	A1	R0748	R467	A3	R0749
CR437	A3	6700	R421	A1	R0696	R468	A3	R0939
CR438	A2	6700	R422	A2	R0777	R469	A3	R0742
CR439	C4	6700	R423	A2	R0741	R470	A3	R0939
CR440	B2	6700	R424	A2	R0748	R471	A3	R0728
Q400	B5	15840	R425	AB2	R0696	R472	A3	R0728
Q401	B5	15840	R426	A2	R0748	R473	A2	R0777
Q402	A4-5	15840	R427	A2	R0696	R474	A2	R0742
Q403	A5	15840	R428	C1	R0768	R475	A5	R1498
Q404	A1	Q0193	R429	C1	R0749	R476	A5	R1498
Q405	A1	Q0193	R430	B1	R0821			



100 MHz READOUT DECODER

SECTION 6 — 50 MC READOUT

6-1 50MC READOUT DECODER UNIT

6-2 (Refer to Schematic Dwg. 12977 or 12978 (Storage Unit) In Table 1 below, the output combinations for the ring-of-5 counter are presented together with the decoding scheme for translating these combinations to the decimal system. Although there are ten unique combinations of ABCDE outputs in the ring-of-5 sequence, recall that these steps resulted from alternate positive and negative input levels, each representing one-half cycle of input signal. Two complete sequences are required to represent ten full cycles of input signal. A sixth variable "X" has been added to provide sufficient information for the translation to decimal code. The "X" variable is the "0" or "1" binary output from pin 20 of the 50MC amplifier. The 0's and X's represent inverted pairs of the same output. With reference to sheet 1 of of schematic Dwg. 12977, Q403 and Q404 provide the signal inversion for the X_o and X_x output. The pairs of transistors Q405/Q406, Q407/Q408, etc., provide signal inversion of the A, B, C, D, and E outputs.

6-3 1st Digit (50MC) Bi-quinary Drive Circuit (Refer to sheet 2 of Dwg. 12977). The 50MC Read-out bi-quinary drive circuit, consisting of transistors Q417 through Q425, is almost identical to the general type of Bi-qui drive circuit described under "Decade Units".

Table 6-1 Ring-of-5 Outputs

Input	Stage:	A	B	C	D	E	X(2)	Combinations For Translation to Decimal Count
0	(3)	1	1	1	0	0	0	
		0	1	1	0	0	0	0,1 = $X_oC_xE_o$ (1)
1		0	1	1	1	0	0	
		0	0	1	1	0	0	
2		0	0	1	1	1	0	
		0	0	0	1	1	0	
3		1	0	0	1	1	0	2,3 = $X_oB_oE_x$
		1	0	0	0	1	0	
4		1	1	0	0	1	0	
		1	1	0	0	0	0	4,5 = Not 0/1,2/3, 6/7, or 8/9
5		1	1	1	0	0	1	
		0	1	1	0	0	1	
6		0	1	1	1	0	1	
		0	0	1	1	0	1	
7		0	0	1	1	1	1	6,7 = $X_xA_oD_x$
		0	0	0	1	1	1	
8		1	0	0	1	1	1	
		1	0	0	0	1	1	8,9 = $X_xA_xC_o$
9		1	1	0	0	1	1	
		1	1	0	0	0	1	

+6V 0V

Odd = $X_oA_xB_o + X_oD_xE_o + X_xA_oE_x + X_xB_xD_o$

NOTES:
1. "o" and "x" represent inversions of same output.
2. "X" signal is derived from a special binary.
3. "0" output = off = +6V; "1" output = on = 0 volts.

The binary drive signal to Q417 and Q418 (even-odd drive for the Bi-qui indicator anodes) is provided by the logic matrix of CR413 through CR427, Q415 and Q416. This binary code output also serves as the first binary output for the 1-2-4-8 binary output code (Option D). Additional logic matrices are required for the 2-4-8 binary outputs which complete the code for the first digit. This optional circuitry is indicated within dotted lines on the schematic.

The five gate circuits, Q421 through Q425, constitute the quinary section of the indicator drive. The inputs to each gate correspond to the combinations given in decoding scheme in Table 1. Note that the input code for the 4/5 numerals is simply "not 0/1, 2/3, 6/7, or 8/9" and is derived from the gating diodes CR431 through CR434 rather than directly from the ABCDEX outputs. When none of these diodes are conducting, Q423 conducts, switching on the 4 and 5 cathodes.

Table 6-2 50MC Decoder and Readout Decade Trouble Symptom Guide

(Note: All outputs from amplifier-counter section are assumed to be normal.)

Symptom	Cause or Check
1st digit all odd or even only; other digits are normal.	Odd-even binary (CR413 to CR430, Q415, Q416) defective.
	Check for squarewave output at J402-F with successive input pulses. If binary states do not alternate with each input pulse, first examine display for clue to missing input signal. For example, if both 6 and 7 fail to light, then A_o or D_x input is missing, per Table 1, paragraph 4.9. Check inverter outputs accordingly (Q403 to Q414).
	Check odd-even drive circuit (Q417 to Q420).
1st digit cycles odd-even but otherwise counts erratically	Check the C_o/C_x outputs at collectors of Q409/Q410. This output is not used in the odd-even binary).
1st digit cycles all odd or even over range of 0 to 5 or 4 to 9 only.	X_o/X_x flip-flop or inverter is faulty (Q403 and Q404).
Numeral 4 5 of 1st digit on or off at all times.	Check diodes CR431 to CR434 and Q423.

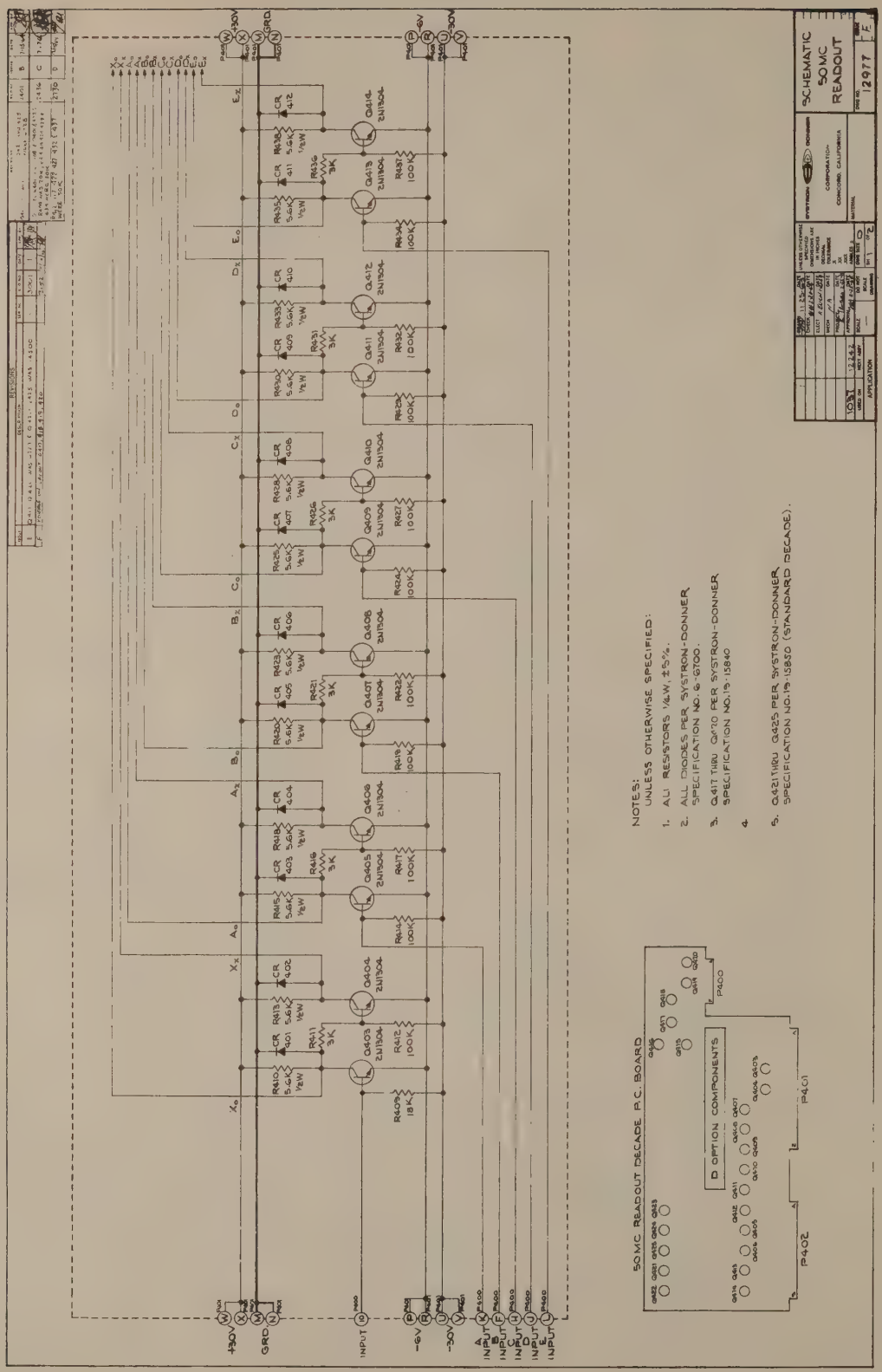
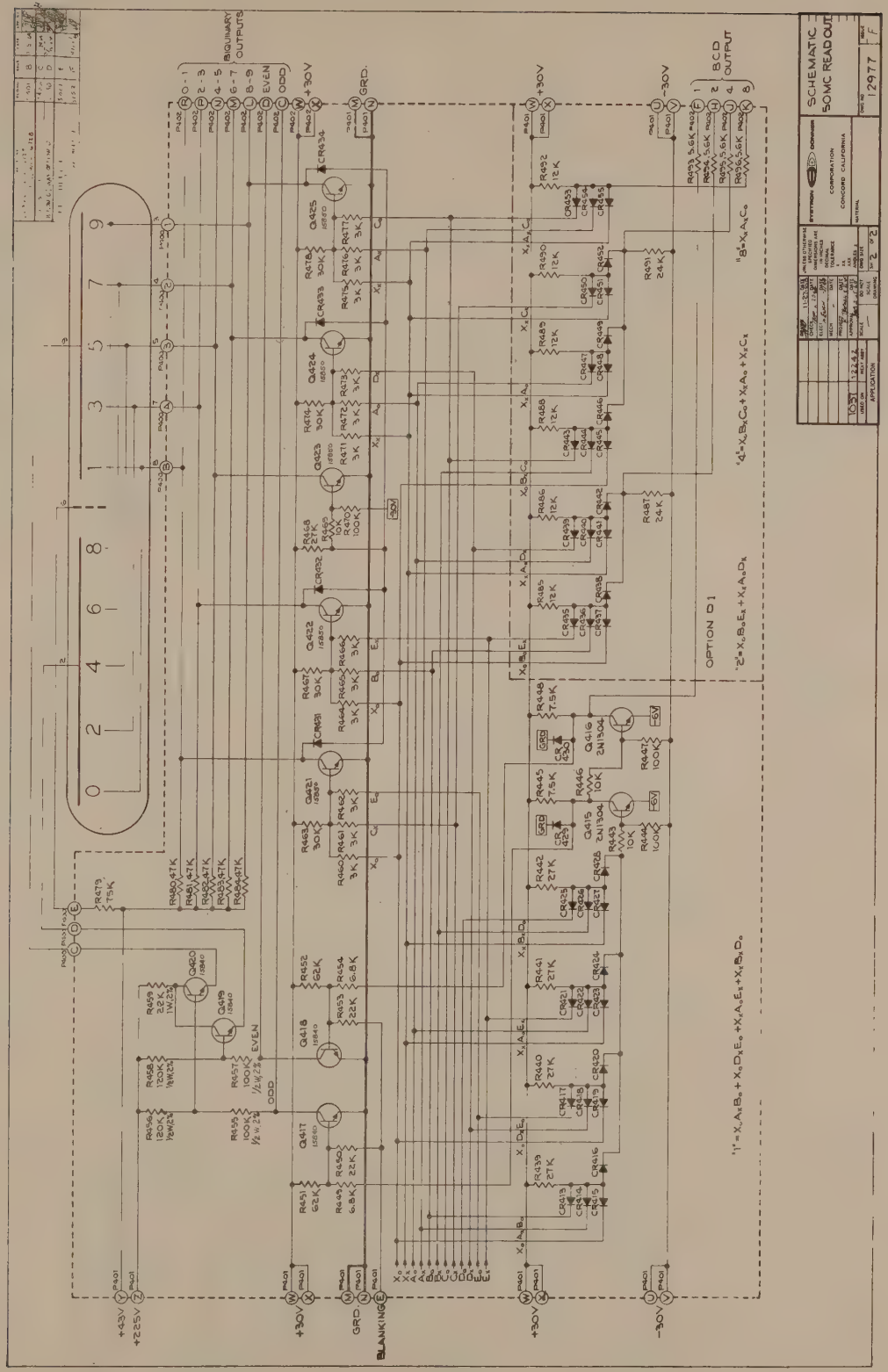
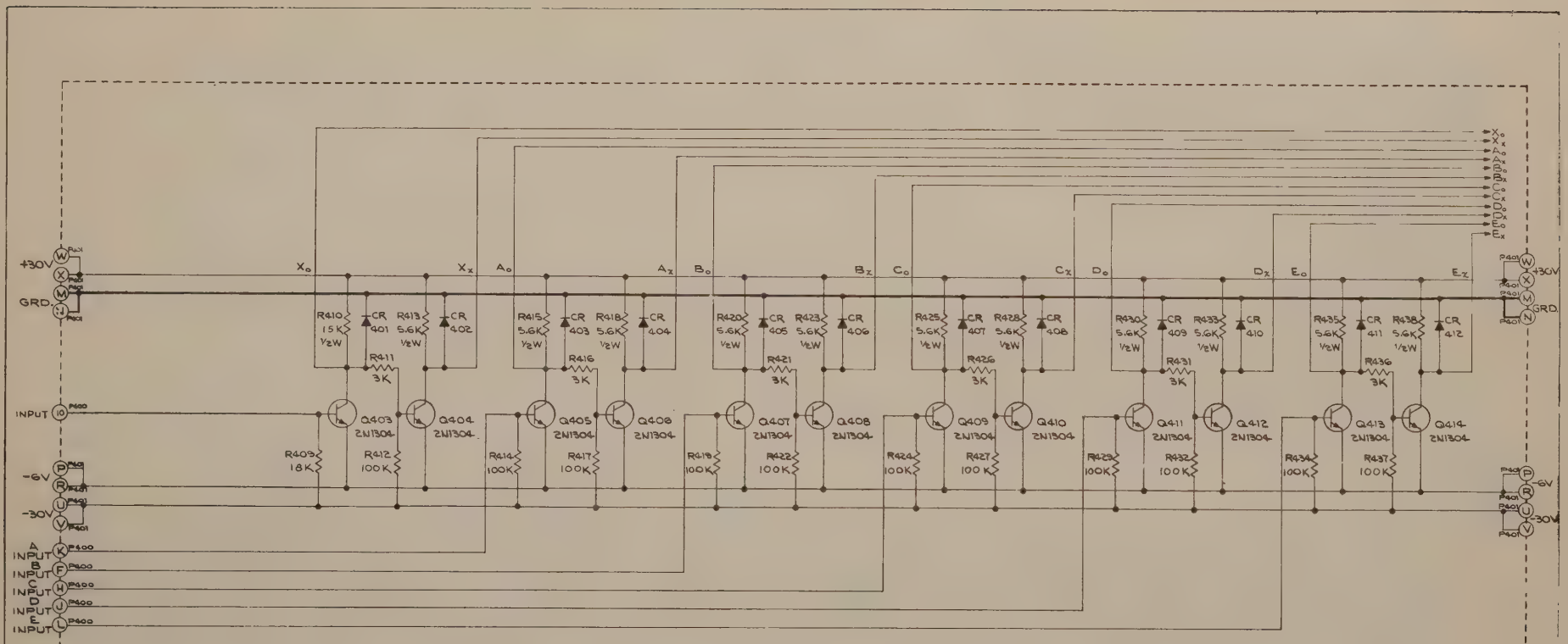
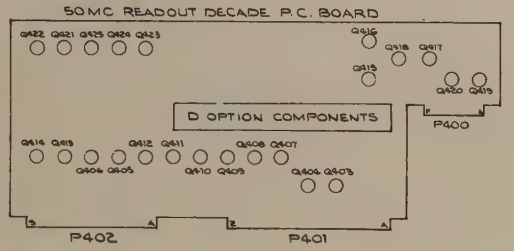


Figure 6-1 50 Mc Standard Readout Schematic No. 12977


SCHEMATIC
50MC READOUT
12977
CONCORD CALIFORNIA
OPTION D1
BINARY OUTPUTS
BCD OUTPUT
EVEN
ODD
BLANKING
+43V
+225V
+30V
GRD
-30V

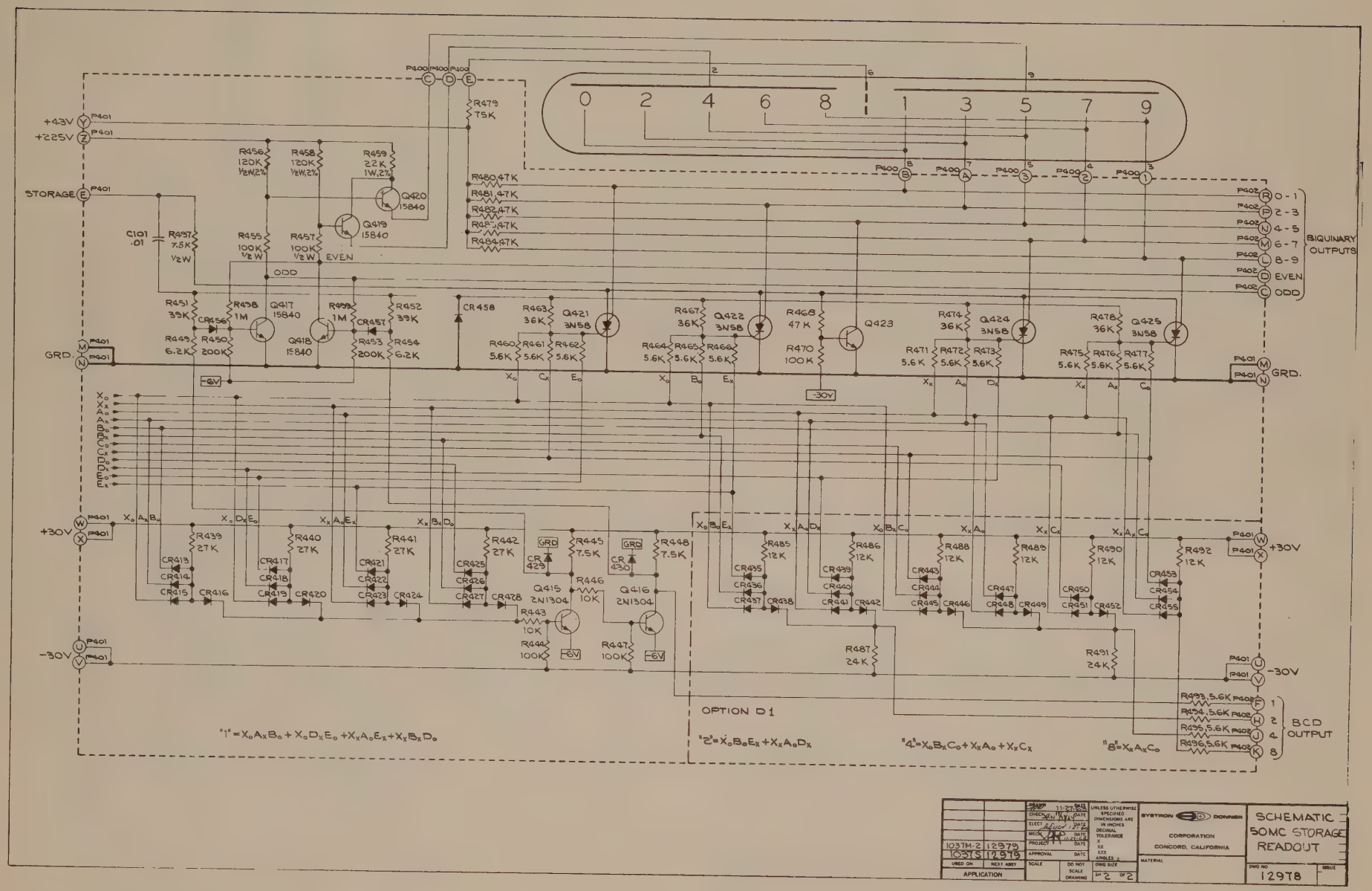




NOTES:
UNLESS OTHERWISE SPECIFIED:

1. ALL RESISTORS ¼W, ±5%.
2. ALL DIODES PER SYSTRON-DONNER SPECIFICATION NO. 6-6700.
3. Q417 THRU Q420 PER SYSTRON-DONNER SPECIFICATION NO. 19-15840.
4.
5. Q423 PER SYSTRON-DONNER SPECIFICATION NO. 19-15850. (STANDARD DECADE)

		DRAWN	DATE	UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES DECIMAL TOLERANCE X .XX .XXX ANGLES ±	SYSTRON DONNER CORPORATION CONCORD, CALIFORNIA	SCHEMATIC 50 MC STORAGE READOUT
		CHECK	DATE			
		ELECT.	DATE			
		MECH.	DATE			
1637M2	12979	PROJECT	DATE		MATERIAL	DWG NO 12978 ISSUE
103TS	12979	APPROVAL	DATE			
USED ON	NEXT ASSY	SCALE	DO NOT SCALE DRAWING	DWG SIZE D SH 1 OF 2		
APPLICATION						



		DRAWN	DATE 11-27-67	UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES DECIMAL TOLERANCE	SYSTRON DONNER CORPORATION CONCORD, CALIFORNIA	SCHEMATIC 50MC STORAGE READOUT	
		CHECKED	DATE				
		ELECT ENG	DATE				
		MECH ENG	DATE				
1037M-2	12979	PROJECT	DATE	X ±.1 XX ±.02 XXX ±.005 ANGLES ±			
10ST5	12979	APPROVAL	DATE		MATERIAL	DWG NO 12978	ISSUE
USED ON	NEXT ASSY	SCALE	DO NOT SCALE DRAWING	DWG SIZE D SHT 2 OF 2			
APPLICATION							

Table 6-3 50 Mc Readout Composite Parts List

Schem. Ref.	Illus. Index	S-D Part
CAPACITORS		
C101	A8	C-0705
DIODES		
CR401	C6	6700
CR402	C6	6700
CR403	C2	6700
CR404	C2	6700
CR405	C5	6700
CR406	C4	6700
CR407	C4	6700
CR408	C3	6700
CR409	C3	6700
CR410	C2	6700
CR411	C1	6700
CR412	C1	6700
CR413	A5	6700
CR414	A4	6700
CR415	A5	6700
CR416	A6	6700
CR417	A5	6700
CR418	A5	6700
CR419	A5	6700
CR420	A5	6700
CR421	A4	6700
CR422	A4	6700
CR423	A4	6700
CR424	A6	6700
CR425	A4	6700
CR426	A4	6700
CR427	A4	6700
CR428	A6	6700
CR429	A7	6700
CR430	A7	6700
CR431	A1	6700N +D1 only
CR432	A1	6700N +D1 only
CR434	A2	6700N +D1 only
CR456	A8	6700S
CR457	A8	6700S
CR458	B1	6700S
TRANSISTORS		
Q403	B6	Q-0073
Q404	B6	Q-0073
Q405	B2	Q-0073
Q406	B1	Q-0073
Q407	B5	Q-0073
Q408	B4	Q-0073
Q409	B4	Q-0073
Q410	B3	Q-0073
Q411	B3	Q-0073
Q412	B2	Q-0073
Q413	B1	Q-0073

Schem Ref.	Illus. Index	S-D Part
TRANSISTORS		
Q414	B1	Q-0073
Q415	A7	Q-0073
Q416	A7	Q-0073
Q417	A8	15840
Q418	A8	15840
Q419	B9	15840
Q420	B9	15840
Q421	A1	Q-0136 15850N +D1
Q422	A1	Q-0136 15850N +D1
Q423	A3	15850 15850N +D1
Q424	A2	Q-0136 15850N +D1
Q425	A2	Q-0136 15850N +D1
RESISTORS		
R409	C6	R-0785
R410	C7	R-0474
R411	B6	R-0711
R412	C6	R-0741
R413	C6	R-0562
R414	C2	R-0741
R415	C2	R-0562
R416	B2	R-0711
R417	C1	R-0741
R418	C1	R-0562
R419	C5	R-0741
R420	C5	R-0562
R421	B4	R-0711
R422	C4	R-0741
R423	C4	R-0562
R424	C4	R-0741
R425	C4	R-0562
R426	B4	R-0711
R427	C3	R-0741
R428	C3	R-0562
R429	C3	R-0741
R430	C3	R-0562
R431	B3	R-0711
R432	C2	R-0741
R433	C2	R-0562
R434	C1	R-0741
R435	C1	R-0562
R436	B1	R-0711
MISCELLANEOUS		
P.C. Board		12241
P.C. Bd. Stiffener		9669
Nylon Bushing		H-0941
Drive Rivets, #38-104-06-13		H-0940
Transistor Pad		H-0515

Schem. Ref.	Illus. Index	S-D Part
RESISTORS		
R437	C1	R-0741
R438	C1	R-0562
R439	A5	R-0824
R440	A5	R-0824
R441	A6	R-0824
R442	A6	R-0824
R443	A6	R-0766
R444	A7	R-0741
R445	A7	R-0884
R446	A7	R-0766
R447	A7	R-0741
R448	A7	R-0884
R449	A8	R-0965
R450	A8	R-0562
R451	A8	R-0748
R452	A8	R-0748
R453	A9	R-0562
R454	A8	R-0965
R455	A9	R-01498
R456	A9	R-91499
R457	A9	R-01498
R458	A9	R-01499
R459	A9	R-01598
R460	A1	R-0821
R461	B1	R-0821
R462	B1	R-0821
R463	A1	R-0705
R464	A1	R-0821
R465	B1	R-0821
R466	B1	R-0821
R467	A1	R-0705
R468	A3	R-0777-S
R470	A3	R-0741-N
R471	A2	R-0821
R472	B2	R-0821
R473	B2	R-0821
R474	A3	R-0705
R475	A2	R-0821
R476	B2	R-0821
R477	B2	R-0821
R478	A2	R-0705
R479	A9	R-0976
R480	A1	R-0777
R481	A1	R-0777
R482	A3	R-0777
R483	A2	R-0777
R484	A2	R-0777
R493	A8	R-0777N
R496	C1	R-0777S
R497	A8	R-0200S
R498	A8	R-0962S
R499	A9	R-0962S

*Applicable to:
Standard Board No. 12242
D1 Option Board No. 15661
S Option Board No. 12979

NOTES:*
1–Components not marked N or S are on all boards regardless of option:
2–Components marked N are on non-storage option boards only:
3–Components marked S are on storage option boards only:
4–Components marked D1 are on D1 options boards only:

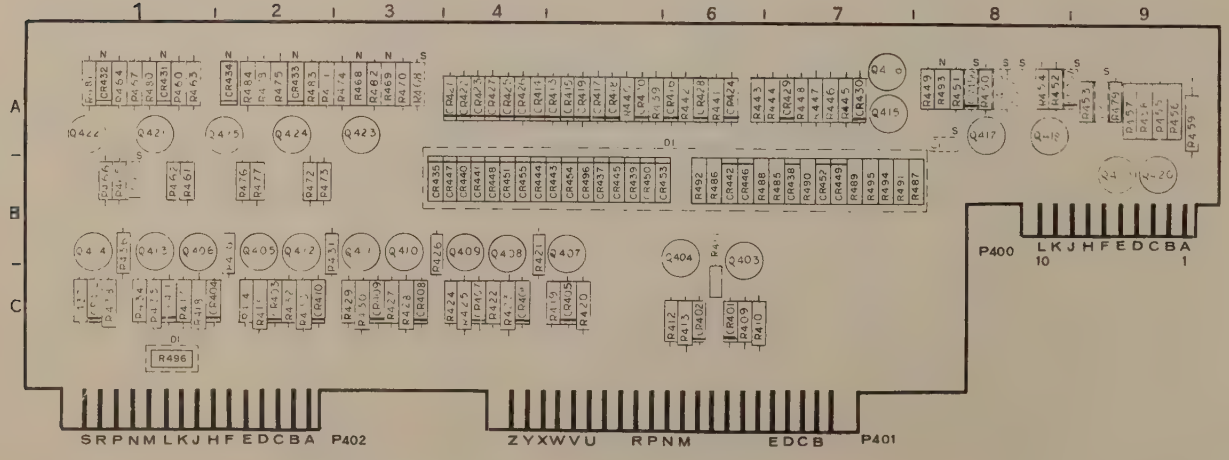


Figure 6-3 50 Mc Readout Composite Parts Location Detail

SECTION 7 – OSCILLATOR AND X-10 MULTIPLIER

7-1 HIGH STABILITY OSCILLATOR (B OPTION) ONLY – ONE MEGACYCLE OUTPUT CIRCUIT

7-2 See Schematic No.12980. The circuitry consists of a divide-by-3 circuit which is used to reduce the 3MC output sinewave frequency from the high stability oscillator to the basic 1 MC signal required for the time base.

7-3 Q801 is an input amplifier stage followed by Q802 the input switch for the ring of 3 counter circuit. The three following identical stages are connected in a ring or loop circuit. When Q802 is on, two of these stages will be off. When Q802 is switched off by the incoming half-cycle of the 3 Mcs oscillator frequency, the second of two successive "off" stages will turn on. On the following half cycle, Q802 is turned on again, and the second of two successive "on" stages will turn off. The net result is that each stage changes state every 1½ cycle of input, or produces a full cycle of square-wave output for every 3 cycles of input signal from the 3 Mcs oscillator, thereby performing the divide-by-3 operation.

7-4 10MC MULTIPLIER CIRCUIT DESCRIPTION

7-5 The 10 Mcs multiplier section consists of a X5 multiplier stage (Q808) followed by a X2 multiplier (Q809) and a tuned amplifier (Q810). Q808, together with a tuned tank circuit at the collector, forms a damped oscillator which is tuned by adjusting for a frequency of 5 Mcs at the base of Q809.

7-6 Q808, operating as a class C amplifier, is triggered into oscillation by the 1Mc rectangular pulses from the shaper circuit of Q807. Two additional stages follow with the Q809 and Q810 circuits being tuned to 10 mcs.

One 10 mcs output is used as the basic frequency for the heterodyne plug-in units. The other 10 mcs output, which is used as the gate input signal during the Test function, is obtained from the output of Q811. The negative output pulse from this shaper stage is peak-limited at –6V by CR809.

7-7 The output of Q811 is also applied through another shaper stage (Q813) to Q816, which is one half of a gate circuit. The Time Base output frequency is applied to the second side of this gate (Q815) through a shaper stage (Q812) similar to Q813. The 10 mcs negative pulse is grounded out in all positions of the time base selector switch, except "10MC" by means of the +6V bias applied to the base of Q816 through the switch transistor Q814. At the same time, the selected time base frequency passes through to the time base output terminal, J800-A. In the 10MC position, a +30V is applied through the time base switch to the base of Q815 and Q814, cutting off both transistors. Consequently, the +6V bias is removed from Q816 which allows the 10 mcs signal to pass.

7-8 10MC MULTIPLIER SERVICE GUIDE

7-9 No operation during 'Test' may indicate loss of 10mcs signal. If present at TIME BASE OUTPUT jack, then the Q811 shaper stage is faulty. If "Test" function is normal except when in the "10 MC time base position, the Gate circuit, Q812 through Q816 is faulty. The same circuitry may also cause the 10mcs time base to be present at all time base positions.

a. If there is no count indication in the TEST function due to no 10mcs output, check for presence of 1 mcs input at P802, pin P, 5 Mcs at base of Q809, and 10mcs at base of Q810, Q811, and Q813.

b. If the 10mcs test signal is off by 20% or more, check the 10mcs multiplier alignment procedure in Chapter 11. (See "Time Base Servicing Guide" also.)

7-10 STANDARD OSCILLATOR CIRCUIT DESCRIPTION

(All options except B)

7-11 The standard oscillator circuit (Dwg.10555) generates a 1 megacycle sine wave which is applied to the Time Base circuits. This oscillator board also contains a 1 Mc shaper, which converts the 1 megacycle sine wave into a 1 megacycle square wave. This square wave synchronizes a multiplier circuit which has a 10 megacycle output. The board also contains an OR gate operated by the time base selector which selects either the Timer Base output frequencies or the 10 megacycle output.

7-12 The oscillator is controlled by a one megacycle crystal housed in an oven. The crystal has an aging rate of 3 parts in 10,000,000 per week.

7-13 The oscillator circuit is a feedback oscillator of the Meacham bridge type, characterized by very low phase shift necessary for frequency stability and undistorted sine wave output. Figure 5.4 shows a simplified schematic with the bridge circuitry emphasized.

7-14 Transistors Q801, Q802 and Q803 form an amplifier with a gain of approximately 1,000. Q803 is an RF power output type of transistor. The signal from the secondary of output transformer T802 is coupled back regeneratively to the oscillator coil T801. C802 tunes this circuit to the fundamental frequency. A sine wave of approximately 2.8 volts nominal amplitude appears at the output terminal. Amplitude stability is maintained by the tungsten filament lamp, I801, in the bridge circuit. The nonlinear characteristics of the lamp compensate for changes in power supply voltages and component aging. R801 is adjustable to compensate for variations in crystal impedance. It should be set to produce an undistorted output sinewave of sufficient amplitude. The frequency can be slightly adjusted by C802 in parallel with T801. In practice, the oscillator is adjusted for proper frequency by means of a one megacycle standard with a 47-ohm resistor substituted for the crystal. Final tuning of the oscillator is accomplished by the trimmer capacitor in series with the crystal.

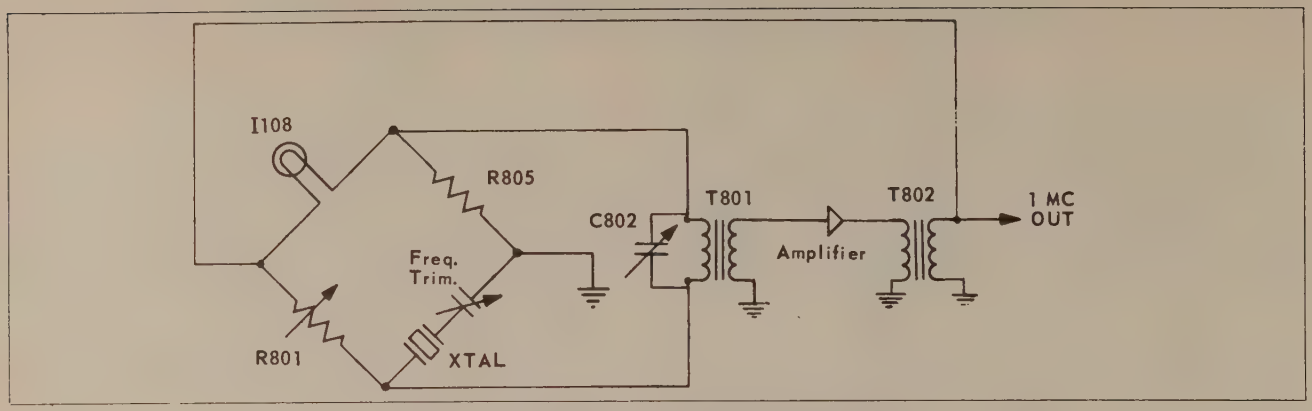


Figure 7-1 Simplified Oscillator Schematic

7-15 SERVICING GUIDE (1 Mc Oscillator)

7-16 If no 1MC sine wave is observed with an oscilloscope at the rear 1 MC connector . . .

1. Check the components in the bridge circuit, especially the lamp I801 and the potentiometer, R801.
2. Check the crystal by removing the oven and inserting a 47-ohm resistor between pins 4 and 7 of the oven socket.
3. Check the voltage levels as shown on the schematic.
4. Check the windings of T801 and T802.

If a distorted (clipped) sinewave appears, re-adjust R801 and also check the bridge and other components.

7-17 10 Mcs MULTIPLIER CIRCUIT DESCRIPTION

7-18 The 10 Mcs multiplier section consists of a X5 multiplier stage (Q804) followed by a X2 multiplier (Q805) and a tuned amplifier (Q807), Q804, together with a tuned tank circuit at the collector, forms a damped oscillator which is tuned by adjusting for a frequency of 5 Mcs at the base of Q805.

7-19 Q804, operating as a class C amplifier is triggered into oscillation by the 1Mc rectangular pulses from the shaper circuit of Q814. Two additional stages follow with the Q805 and Q807 circuits being tuned to 10 mcs. One 10 mcs output is used as the basic frequency for the heterodyne plug-in units (option H). The other 10 mcs output, which is used as the gate input signal during the Test function, is obtained from the output of Q808. The negative output pulse from this shaper stage is peak-limited at -6V by CR801.

7-20 The output of Q807 is also applied through another shaper stage (Q812) to Q811, which is one half of a gate circuit. The Time Base output frequency is applied to the second side of this gate (Q810) through a shaper stage (Q809) similar to Q812. The 10 mcs negative pulse is grounded out in all positions of the time base selector switch, except "10MC" by means of the +6V bias applied to the base of Q811 through the switch transistor Q813. At the same time, the selected time base frequency passes through to the time base output terminal, J800-A. In the 10MC position, a +30V is applied through the time base switch to the base of Q810 and Q813, cutting off both transistors. Consequently, the +6V bias is removed from Q811 which allows the 10mcs signal to pass.

7-21 10MC MULTIPLIER SERVICE GUIDE

7-22 No operation during 'Test' may indicate loss of 10mcs signal. If present at TIME BASE OUTPUT jack, then the Q811 shaper stage is faulty. If "Test" function is normal except when in the "10 MC time base position, the Gate circuit, Q812 through Q816 is faulty. The same circuitry may also cause the 10mcs time base to be present at all time base positions.

7-23 If there is no count indication in the TEST function due to no 10mcs output, check for presence of 1 mcs input at P802, pin P, 2mcs at base of Q809, and 10mcs at base of Q810, Q811, and Q813.

7-24 If the 10mcs test signal is off by 20% or more, check the 10mcs multiplier alignment procedure in Section 12. (See "Time Base Servicing Guide" also.)

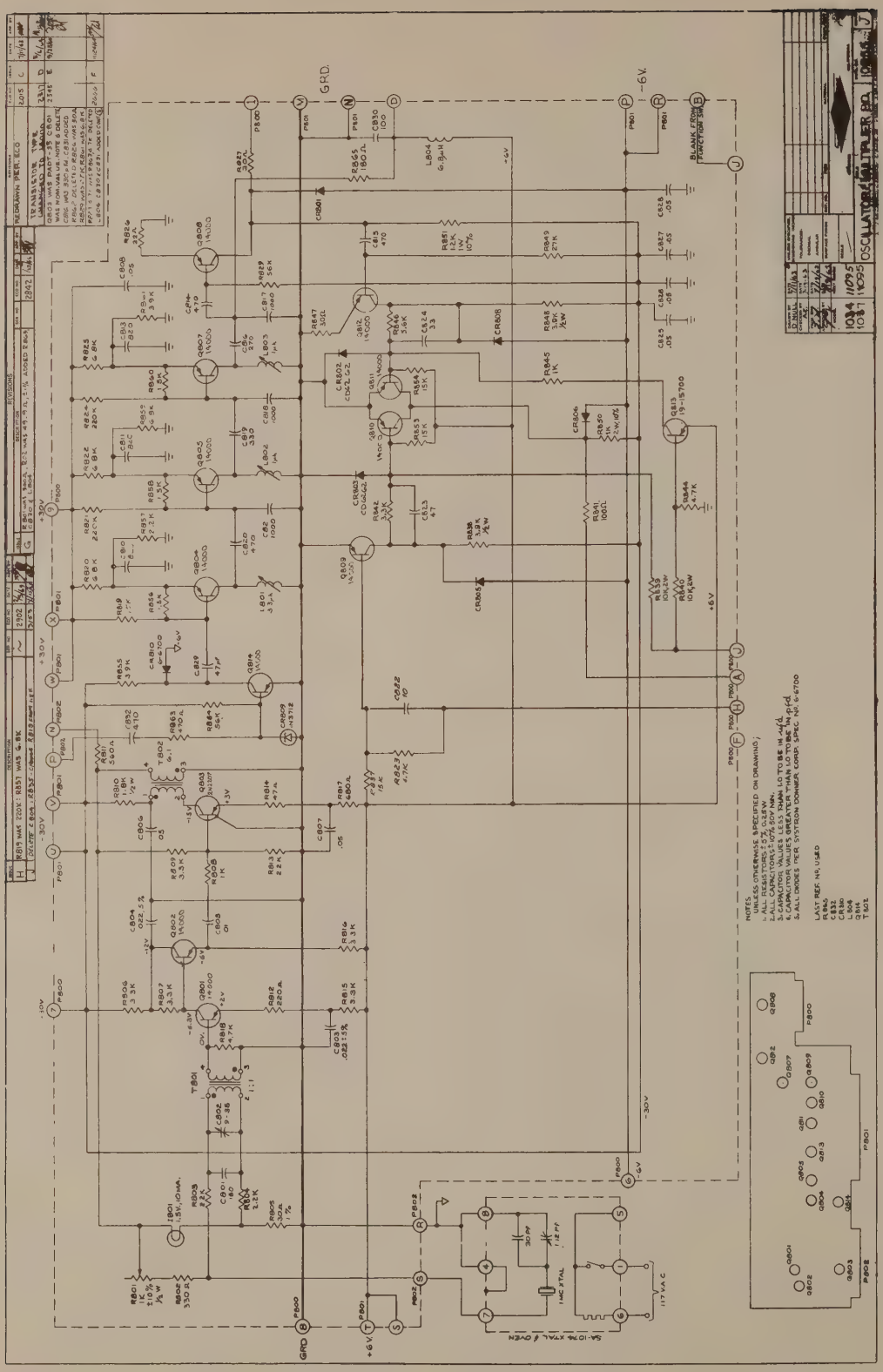


Figure 7-2 Standard Oscillator Multiplier Schematic No. 10555

Table 7-1 Standard Oscillator and Multiplier Parts List

(Refer to Master Parts List for part description.)

Schem Ref	Illus. Index	S-D Part
CAPACITORS		
C801	C1	C-0643
C802	A1	C-0709
C803	B1	C-0706
C804	B1	C-0706
C805	B1	C-0705
C806	B1	C-0708
C807	B1	C-0708
C808	B2	C-0708
C810	B2	C-0681
C811	B3	C-0681
C813	B5	C-0681
C814	A7	C-0542
C815	A6	C-0542
C816	A6	C-0539
C817	A7	C-0543
C818	B3	C-0543
C819	B3	C-0540
C820	B3	C-0542
C821	B3	C-0543
C822	C6	C-0527
C823	C5	C-0533
C824	A4	C-0533
C825	A6	C-0708
C826	C4	C-0708
C827	C4	C-0708
C828	C4	C-0708
C829	B2	C-0533
C830	B7	C-0536
C832	C1	C-0542
DIODES		
CR801	A7	6-6700
CR802	A4	CR-0150
CR803	C5	CR-0150
CR805	C5	6-6700
CR806	C5	6-6700
CR808	A5	6-6700
CR809	C2	CR-0173
CR810	C3	6-6700
INDICATORS		
I801	B1	I-0041
INDUCTORS		
L801	B2	L-0051
L802	B4	L-0050
L803	B6	L-0050
L804	A7	L-0053
TRANSISTORS		
Q801	B1	14000
Q802	B1	14000
Q803	C1	0087
Q804	B2	14000
Q805	B3	14000
Q807	B5	14000
Q808	A7	14000
Q809	B5	14000
Q810	B5	14000
Q811	B5	14000
Q812	A6	14000
Q813	B4	0055
Q814	C2	14000
TRANSFORMERS		
T801	A1	T-0084
T802	C1	T-0083
RESISTORS		
R801	A1	R-1288
R802	B1	R-0662
R803	A1	R-0749
R804	A1	R-0749
R805	A1	R-1313
R806	B1	R-0742
R807	B1	R-0742
R808	C1	R-0765
R809	C1	R-0742
R810	B1	R-0277
R811	C1	**R-0819**
R812	B1	R-0760
R813	C1	R-0749
R814	C1	R-0743
R815	B1	R-0742
R816	B1	R-0742
R817	B1	R-1234
R818	A1	R-0892
R819	A2	R-0728
R820	A3	R-0696
R821	A3	R-0467
R822	A3	R-0696
R823	C6	R-0892
R824	A5	R-0967
R825	A5	R-0696
R826	A7	R-1436
R827	A7	R-1549
R829	A7	R-1235
R837	A5	R-0728
R838	C5	R-0616
R839	C3	R-1113
R840	C3	R-1113
R841	C5	R-0966
R842	C5	R-0742
R844	C4	R-0892
R845	B4	R-0765
R846	A4	R-0821
R847	A5	R-1549
R848	A4	R-0616
R849	A6	R-0824
R850	C4	R-0330
R851	A6	R-0492
R853	B4	R-0728
R854	B4	R-0728
R855	C2	R-0939
R856	A2	R-0783
R857	A2	R-0749
R858	A3	R-0783
R859	A3	R-0696
R860	A5	R-0783
R861	A5	R-0939
R863	C2	R-1044
R864	C2	R-1235
R865		R-1233

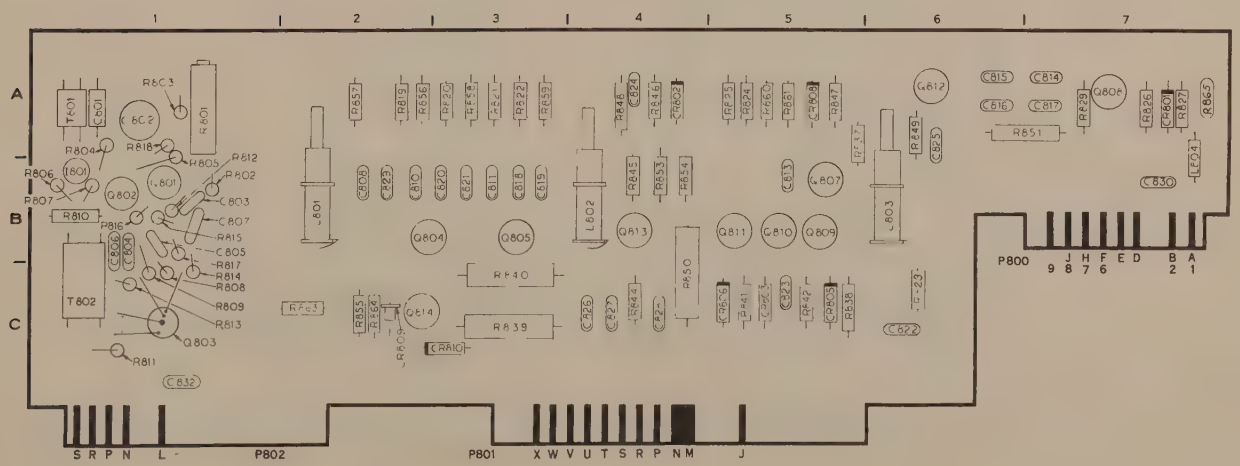


Figure 7-3 Standard Oscillator Multiplier Parts Location Detail, Assy. 11095

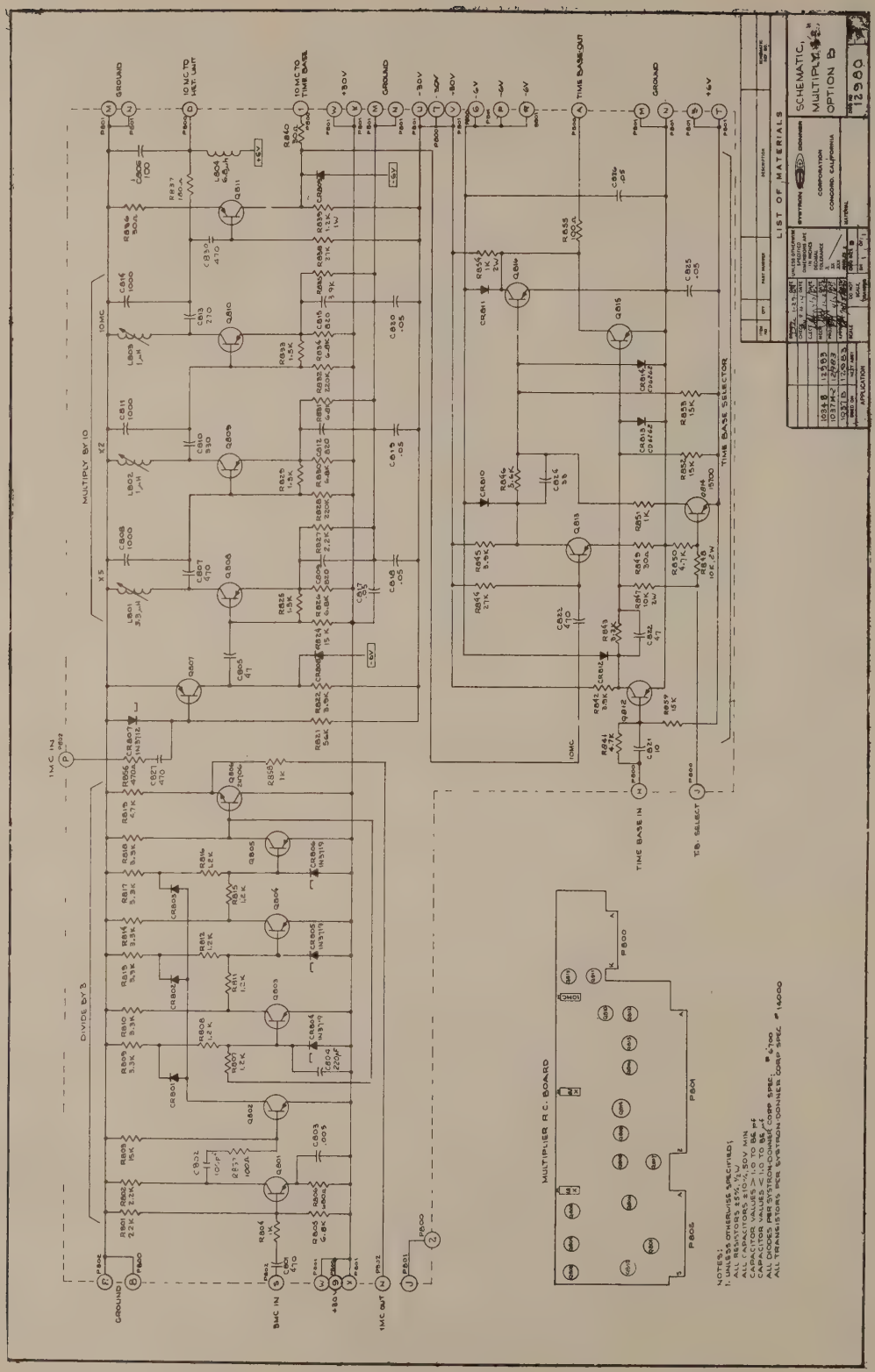


Figure 7-4 B Option Multiplier Divide-by-3 Schematic No. 12980

Table 7-2 Multiplier Divide-by-3 (B Option) Parts List

Schem. Ref.	Illus. Index	S-D Part
CAPACITORS		
C801	C1	C-0542
C802	C1	C-0536
C803	C2	C-0325
C804	A1	C-0538
C805	B3	C-0533
C806	B7	C-0536
C807	B3	C-0542
C808	B3	C-0543
C809	B3	C-0681
C810	B4	C-0540
C811	B4	C-0543
C812	B4	C-0681
C813	A8	C-0539
C814	A8	C-0543
C815	B6	C-0681
C817	B3	C-0708
C818	C4	C-0708
C819	C5	C-0708
C820	B7	C-0708
C821	C7	C-0527
C822	C6	C-0533
C823	A8	C-0542
C824	A5	C-0531
C825	B5	C-0708
C826	C5	C-0708
C827	C3	C-0542
C830	A8	C-0542
DIODES		
CR801	B1	6700
CR802	B1	6700
CR803	B2	6700
CR804	A1	CR-0188
CR805	A1	CR-0188
CR806	A2	CR-0188
CR807	C3	CR-0173
CR808	C3	6700
CR809	A8	6700
CR810	A6	6700
CR811	C5	6700
CR812	C6	6700
CR813	C6	CR-0150
CR814	A5	CR-0150

Schem. Ref.	Illus. Index	S-D Part
TRANSISTORS		
Q801	C1	14000
Q802	B1	14000
Q803	A1	14000
Q804	A1	14000
Q805	A2	14000
Q806	B2	Q-0130
Q807	C3	14000
Q808	B3	14000
Q809	B4	14000
Q810	B6	14000
Q811	A7	14000
Q812	B6	14000
Q813	A7	14000
Q814	B4	15700
Q815	B6	14000
Q816	B5	14000
RESISTORS		
R801	C1	R-0527
R802	C1	R-0351
R803	C2	R-0474
R804	C1	R-0278
R805	C1	R-0514
R806	C2	R-0321
R807	B2	R-0260
R808	B1	R-0260
R809	B1	R-0136
R810	B1	R-0136
R811	B1	R-0260
R812	B1	R-0260
R813	B1	R-0136
R814	B2	R-0136
R815	B2	R-0260
R816	B2	R-0260
R817	B2	R-0136
R818	B2	R-0136
R819	C2	R-0522
R821	C3	R-0137
R822	C3	R-0616
R824	A3	R-0474
R825	A3	R-0265
R826	A3	R-0514

Schem. Ref.	Illus. Index	S-D Part
RESISTORS		
R827	A3	R-0351
R828	A4	R-0264
R829	A4	R-0265
R830	A4	R-0514
R831	A4	R-0514
R832	A6	R-0264
R833	A6	R-0265
R834	A5	R-0514
R835	A6	R-0616
R836	B7	R-0424
R837	A8	R-0725
R838	A8	R-0564
R839	A8	R-0492
R840	A8	R-0424
R841	C6	R-0522
R842	C7	R-0616
R843	C6	R-0136
R844	A7	R-0564
R845	A5	R-0616
R846	A5	R-0562
R847	C4	R-1113
R848	C4	R-1113
R849	A6	R-0424
R850	C5	R-0522
R851	B5	R-0278
R852	B5	R-0474
R853	C2	R-0474
R854	C5	R-0330
R855	C6	R-0466
R856	C2	R-0677
R857	B1	R-0466
R858	C2	R-0278
R859	B7	R-0278
INDUCTORS		
L801	A-2	15320-2
L802	A-4	15320-1
L803	A-7	15320-1
L804	B-7	E-0053
MISCELLANEOUS		
PC Board, Mult. -3 Assy.		12983
PC Board (fab)		12982
PC Board Stiffener, Silk Screen Ass'y.		15331
PC Board Stiffener		9669
Nylon Bushing		H-0941
Drive Rivet		H-0940
Transistor Pad		H-0515

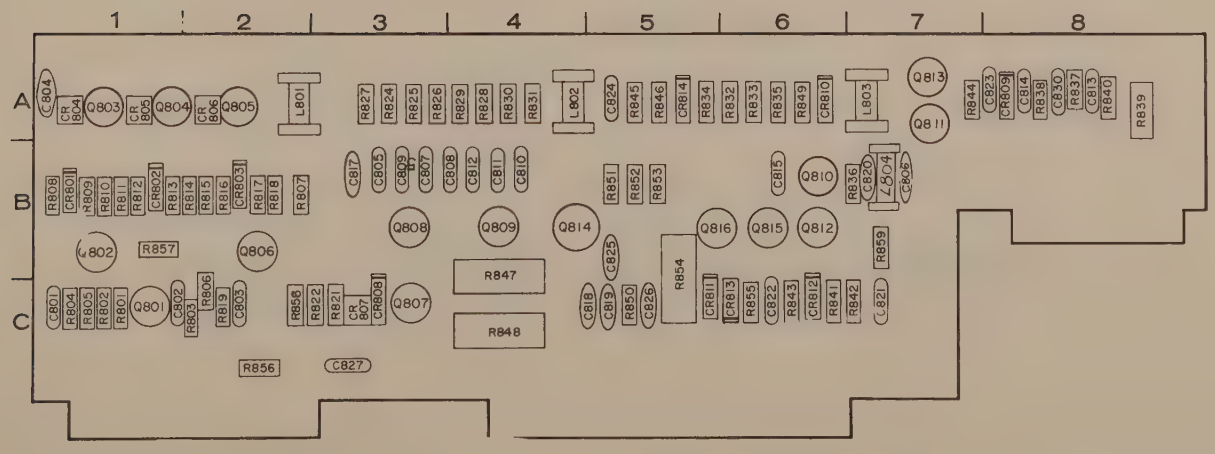


Figure 7-5 B Option Multiplier Divide-by-3 Parts Location Detail No. 12983

SECTION 8 — TIME BASE

8-1 GENERAL DESCRIPTION

8-2 Refer to Dwg. 15423. The Time Base circuit contains five decade stages connected in series, each one of which divides the input frequency applied to it by a factor of ten. A 1 MC output signal from the Multiplier and Divide-by-3 oscillator multiplier modules is applied at pin P201-L to a Schmitt trigger shaper circuit Q19-Q20. The output of Q20 is then applied directly to the 2 MC decade (the first in the chain of five) and also through Q21 to the X10 stage in the Multiplier module. The chain of five decades generate the following time base frequencies.

Table 8-1 Time Base Frequencies

Decade	P200 Terminal	Output frequency (Period)
1	4	100 KC (0.01 msec)
2	6	10 KC (0.1 msec)
3	B	1 KC (1 msec)
4	C	100 cps (0.01 sec)
5	5	10 cps (0.1 sec)

The remaining two time base frequencies (1 cps and 0.1 cps) are generated within the Display and Reset circuit module.

8-3 The basic decade or decimal counting unit consists of four binaries which operate in a chain to produce one output pulse for every ten input pulses. At the same time, ten discreet states of collector voltage levels of the four binaries are obtained to produce a scale-of-ten or binary-coded decimal output.

8-4 Each binary is triggered into one of two stable states by positive input pulses. In the "1" state, the left or odd-numbered transistor (relative to the schematic) conducts and the binary output level at the collector of the non-conducting transistor is -6 volts ("-" level) for PNP type decades. In the "0" state, the opposite condition exists and the output is +6 volts ("+" level). In the simplified diagram of Figure 8-1, the shaded areas indicate which transistors in the decade are conducting at the reset condition. The binary logic is 0-0-0-0, which is equivalent to a coded "0". (The X1-X10 decade in the Display and Reset circuit resets to "9"; all other decades are not reset in the time base).

8-5 The first three binaries have dual mode triggering through the parallel input steering diode connections and therefore change from one state to another on receiving successive positive pulses from the preceding stage or decade input. In dual mode triggering, one steering diode is cutoff by the -6 volts at the collector of the non-conducting transistor. The positive input pulse passes through the other steering diode and cuts off the conducting transistor. The following positive pulse will not pass through the same diode because of the reversal of biasing. Binary A alternates with every input pulse or "count," Binary B with every second count (when not inhibited), and Binary C with every fourth count. Binary D has two single-mode trigger inputs: a) the positive output of Binary A, being coupled to the odd-numbered transistor, will cause it to trigger to the "0" state only; b) similarly, the positive output of Binary C, being coupled to the even-numbered transistor, will cause it to trigger to the "1" state only. A third special condition exists at the input to Binary B: c) Feedback from the output of Binary D through R20 and the normal input through C9 form an AND gate. A positive input will pass only if the output of Binary D is positive. On counts 8 and 9, the output is negative, which prevents the next positive pulse from passing through the gate. Therefore, Binary B is inhibited from triggering at count "0". The complete sequence of events is shown in Figure 10-2. The arrows in the illustration indicate the triggering modes discussed above.

8-6 The time base output frequency selected by the Time Base switch (Section S1-G) is applied through terminal P200-8 to a shaper circuit (Q17, Q18). The shaper output is applied through terminal P200-7 to the time base selector circuit in the Multiplier circuit module.

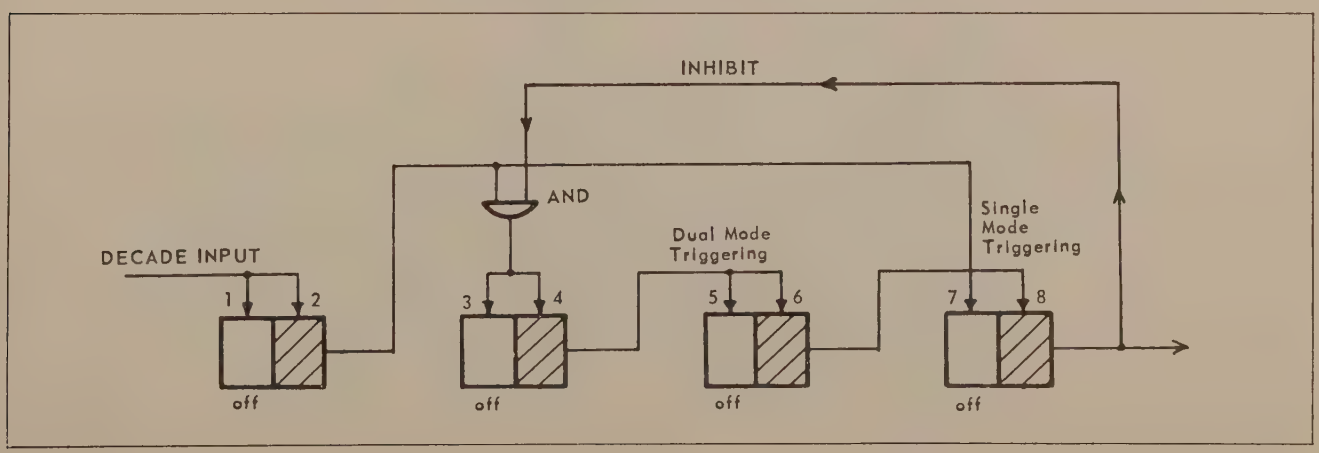


Figure 8-1 Simplified Diagram of PNP Decade Unit

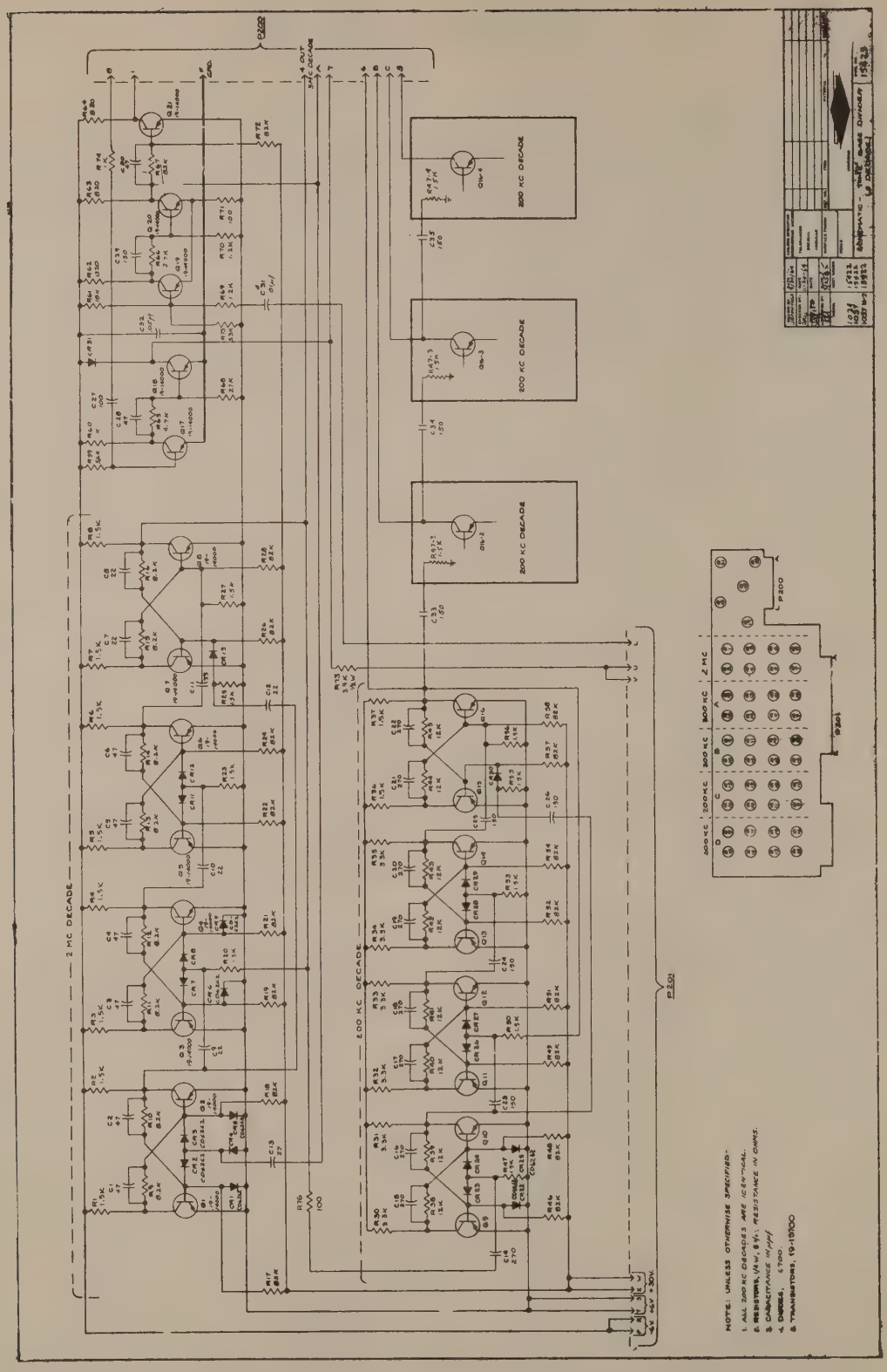


Figure 8-2 Time Base Divider Schematic No. 15423

Table 8-1 Time Base Parts List

CAPACITORS

Schem. Ref.	Illus. Index	S-D Part
C1	A5	C-0533
C2	A5	C-0533
C3	B5	C-0533
C4	B5	C-0533
C5	C5	C-0533
C6	C5	C-0533
C7	D5	C-0529
C8	D5	C-0529
C9	B5	C-0529
C10	B5	C-0529
C11	C5	C-0531
C12	C5	C-0529
C13	A5	C-05[illegible]
C14	D4	C-0539
C15	D4	C-0539
C16	D4	C-0539
C17	C4	C-0539
C18	C4	C-0539
C19	B4	C-0539
C20	B4	C-0539
C21	A4	C-0539
C22	A4	C-0539
C23	C4	C-0537
C24	B4	C-0537
C25	B4	C-0537
C26	C6	C-0537
C27	B6	C-0536
C28	B6	C-0533
C29	B6	C-0537
C30	B6	C-0533
C31	D5	C-0562
C32	A6	C-0708
C33		C-0537
C34		C-0537
C35		C-0557
C15-2	A3	C-0539
C16-2	B3	C-0539
C17-2	B3	C-0539
C18-2	B3	C-0539
C19-2	C3	C-0539
C20-2	C3	C-0539
C21-2	D3	C-0539
C22-2	D3	C-0539
C23-2	B3	C-0537
C24-2	B3	C-0537
C25-2	C3	C-0537
C26-2	C3	C-0537
C15-3	D2	C-0539
C16-3	D2	C-0539
C17-3	C2	C-0539
C18-3	C2	C-0539
C19-3	B2	C-0539
C20-3	B2	C-0539
C21-3	A2	C-0539
C22-3	A2	C-0539
C23-3	C2	C-0537
C24-3	B2	C-0537
C25-3	B2	C-0537
C26-3	C2	C-0537
C15-4	A1	C-0539
C16-4	B1	C-0539
C17-4	B1	C-0539
C18-4	B1	C-0539
C19-4	C1	C-0539
C20-4	C1	C-0539
C21-4	D1	C-0539
C22-4	D1	C-0539
C23-4	D1	C-0537
C24-4	B1	C-0537
C25-4	C1	C-0537
C26-4	C1	C-0537

DIODES

Schem. Ref.	Illus. Index	S-D Part
CR1	B5	CR-0150
CR2	A5	CR-0150
CR3	A5	CR-0150
CR4	A5	6700
CR5	B5	CR-0150
CR6	C5	CR-0150
CR7	B5	6700
CR8	B5	6700
CR9	C5	CR-0150
CR11	C5	6700
CR12	C5	6700
CR13	C5	6700
CR22	C4	CR-0150
CR23	D4	6700
CR24	D4	6700
CR25	C4	CR-0150
CR26	C4	6700
CR27	C4	6700
CR28	B4	6700
CR29	B4	6700
CR30	B4	6700
CR31	A6	6700
CR22-2	B2	CR-0150
CR23-2	A2	6700
CR24-2	A1	6700
CR25-2	B3	CR-0150
CR26-2	B3	6700
CR27-2	B3	6700
CR28-2	C3	6700
CR29-2	C3	6700
CR30-2	D3	6700
CR22-3	C2	CR-0150
CR23-3	D2	6700
CR24-3	D2	6700
CR25-3	C2	CR-0150
CR26-3	C2	6700
CR27-3	C2	6700
CR28-3	B2	6700
CR29-3	B2	6700
CR30-3	B2	6700
CR22-4	B1	CR-0150
CR23-4	A1	6700
CR24-4	A1	6700
CR25-4	B1	CR-0150
CR26-4	B1	6700
CR27-4	B1	6700
CR28-4	C1	6700
CR29-4	C1	6700
CR30-4	D1	6700

TRANSISTORS

Schem Ref	Illus Index	S D Part
Q1	A5	14000
Q2	A5	14000
Q3	B5	14000
Q4	B5	14000
Q5	C5	14000
Q6	C5	14000
Q7	D5	14000
Q8	D5	14000
Q9	D4	15700
Q10	D4	15700
Q11	C4	15700
Q12	C4	15700
Q13	B4	15700
Q14	B4	15700
Q15	A4	15700
Q16	A4	15700
Q17	B6	14000
Q18	B6	14000
Q19	A6	14000
Q20	B6	14000
Q21	A6	14000
Q9-2	A3	15700
Q10-2	A3	15700

Schem Ref	Illus Index	S D Part
Q11-2	B3	15700
Q12-2	B3	15700
Q13-2	C3	15700
Q14-2	C3	15700
Q15-2	D3	15700
Q16-2	D3	15700
Q9-3	D2	15700
Q10-3	D2	15700
Q11-3	C2	15700
Q12-3	C2	15700
Q13-3	B2	15700
Q14-3	B2	15700
Q15-3	A2	15700
Q16-3	A2	15700
Q9-4	A1	15700
Q10-4	A1	15700
Q11-4	B1	15700
Q12-4	B1	15700
Q13-4	C1	15700
Q14-4	C1	15700
Q15-4	D1	15700
Q16-4	D1	15700

RESISTORS

Schem. Ref.	Illus. Index	S-D Part
R1	A5	R-0783
R2	A5	R-0783
R3	B5	R-0783
R4	B5	R-0783
R5	C5	R-0783
R6	C5	R-0783
R7	D5	R-0783
R8	D5	R-0783
R9	A5	R-0883
R10	B5	R-0883
R11	B5	R-0883
R12	B5	R-0883
R13	C5	R-0883
R14	C5	R-0883
R15	D5	R-0883
R16	D5	R-0883
R17	B5	R-0784
R18	A5	R-0784
R19	B5	R-0784
R20	B5	R-0784
R21	B4	R-0784
R22	C5	R-0784
R23	C5	R-0784
R24	C5	R-0784
R25	C5	R-0784
R26	D5	R-0784
R27	D5	R-0784
R28	D5	R-0784
R30	D4	R-0742
R31	D4	R-0742
R32	C4	R-0742
R33	C4	R-0742
R34	B4	R-0742
R35	B4	R-0742
R36	A4	R-0783
R37	A4	R-0783
R38	D2	R-0759
R39	C2	R-0759
R40	C2	R-0759
R41	C2	R-0759
R42	B2	R-0759
R43	B2	R-0759
R44	A2	R-0759
R45	B4	R-0759
R46	C4	R-0784
R47	D4	R-0783
R48	D4	R-0784
R49	C4	R-0784
R50	C4	R-0783
R51	C4	R-0784
R52	B4	R-0784
R53	B4	R-0783
R54	B4	R-0784
R55	A6	R-0883
R56	A6	R-0883
R57	B6	R-0784
R58	A6	R-0784
R59	A6	R-0821
R60	A6	R-0765
R61	A6	R-0785
R62	A6	R-0762
R63	A6	R-0762
R64	A6	R-0762
R65	B6	R-0892
R66	B6	R-0937
R67	A6	R-0883
R68	B6	R-0824
R69	B6	R-0309
R70	A6	R-0309
R71	A6	R-0966
R72	A6	R-0784
R73	B6	R-0939
R74	B6	R-0765
R75	A6	R-0742
R76	D5	R-0966
R30-2	B3	R-0742
R31-2	A3	R-0742
R32-2	B3	R-0742
R33-2	B3	R-0742
R34-2	C3	R-0742
R35-2	C3	R-0742
R36-2	D3	R-0783
R37-2	D3	R-0759
R38-2	A3	R-0759
R39-2	B3	R-0759

Schem. Ref.	Illus. Index	S-D Part
R40-2	B3	R-0759
R41-2	C3	R-0759
R42-2	C3	R-0759
R43-2	C3	R-0759
R44-2	D3	R-0759
R45-2	D3	R-0759
R46-2	B3	R-0784
R47-2	A3	R-0793
R48-2	A3	R-0794
R49-2	C3	R-0794
R50-2	B3	R-0783
R51-2	B3	R-0784
R52-2	C3	R-0784
R53-2	C3	R-0783
R54-2	C3	R-0784
R55-2	D3	R-0783
R56-2	D3	R-0783
R57-2	D3	R-0784
R58-2	D3	R-0784
R30-3	D2	R-0742
R31-3	D2	R-0742
R32-3	C2	R-0742
R33-3	C2	R-0742
R34-3	B2	R-0742
R35-3	B2	R-0742
R36-3	A2	R-0783
R37-3	A2	R-0783
R38-3	D2	R-0759
R39-3	C2	R-0759
R40-3	C2	R-0759
R41-3	C2	R-0759
R42-3	B2	R-0759
R43-3	B2	R-0759
R44-3	A2	R-0759
R45-3	B2	R-0759
R46-3	C2	R-0784
R47-3	D2	R-0783
R48-3	D2	R-0784
R49-3	C2	R-0784
R50-3	C2	R-0783
R51-3	C2	R-0784
R52-3	B2	R-0784
R53-3	B2	R-0783
R54-3	B2	R-0784
R55-3	B2	R-0783
R56-3	D2	R-0783
R57-3	B2	R-0784
R58-3	A2	R-0784
R30-4	B1	R-0742
R31-4	A1	R-0742
R32-4	B1	R-0742
R33-4	B1	R-0742
R34-4	C1	R-0742
R35-4	C1	R-0742
R36-4	D1	R-0783
R37-4	D1	R-0783
R38-4	A1	R-0759
R39-4	B1	R-0759
R40-4	B1	R-0759
R41-4	C1	R-0759
R42-4	C1	R-0759
R43-4	C1	R-0759
R44-4	D1	R-0759
R45-4	D1	R-0759
R46-4	B1	R-0784
R47-4	A1	R-0783
R48-4	A1	R-0784
R49-4	C1	R-0783
R50-4	B1	R-0784
R51-4	B1	R-0784
R52-4	C1	R-0784
R53-4	C1	R-0783
R54-4	C1	R-0784
R55-4	D1	R-0783
R56-4	D1	R-0783
R57-4	D1	R-0784
R58-4	D1	R-0784

MISCELLANEOUS

P.C. Board	15190
P.C. Board Stiffener S.S. Assy.	15477
P.C. Board Stiffener	9669
Nylon Bushing	H-0941
Drive Rivet #38-104-06-13	H-0940

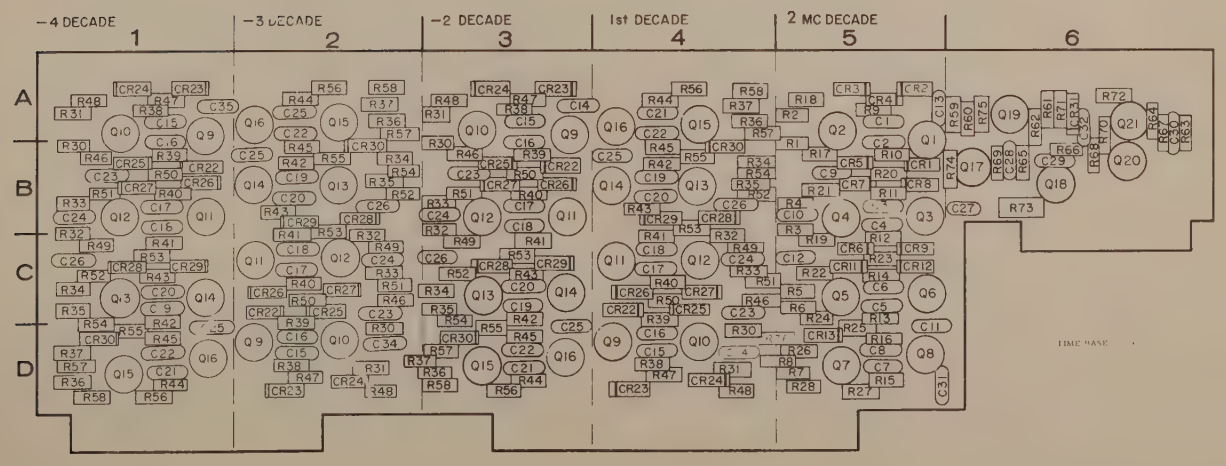


Figure 8-3 Time Base Divider Parts Location Detail, Assy. 15422

SECTION 9 — DISPLAY AND RESET

9-1 CIRCUIT DESCRIPTION

This section is applicable to all counter options. (Refer to Dwg. No. 14881)

9-3 Control Binaries. The output pulses from the input amplifiers and from the time base circuitry are applied to the start and stop inputs of the control binaries. These inputs respond only to positive-going input pulses by virtue of diodes CR8 and CR12.

9-4 Assuming that the control circuitry is in the "reset" condition (all Indicator tubes register "o"), a positive "start" pulse is applied through C10 which turns off Q3 and turns on Q4 in the binary circuit. A positive-going output at the collector of Q4 turns Q5 off and Q6 on in the following binary. Consequently, a high (zero volt) Gate level output occurs at terminal F which opens the gate and causes the decimal counting units to cycle, provided that there is a "count" input signal present. If a stop impulse were received prior to the "start" pulse, this would tend to turn off the already-off Q4 and, therefore, nothing would happen.

9-5 When a positive "stop" pulse arrives, only binary Q5/Q6 flips, causing the Gate level output to change to a −6 volt (gate closed) level, as limited by CR31. Because the collectors of both Q3 and Q6 are now at zero potential, a +10 volts potential is applied through R52, turning off Q14 (an NPN type transistor), and producing a −6 volt End-of-Count Signal at terminal K which is connected to the blanking-storage gate in the power supply. At the same time, Q10 is turned off and initiates the reset signal after a delay for display interval.

9-6 Reset Signal When Q10 is turned off by the "stop" pulse, capacitor C8 charges up towards +30 volts through the series network including R17 and the DISPLAY time control. When the voltage rises to the peak point of Q11 this unijunction transistor fires, discharging C8. The resultant pulse across R8 drives the following reset pulse circuitry. The output of Q12 resets the start-stop binaries.

9-7 The display time delay interval is determined by the rate of charge of C8 and can be adjusted by the Display control. When the display control switch is in the "infinite" position, the charge path is opened and will never charge so that a manual reset pulse is required.

9-8 Similarly, no reset will occur if terminal B (P302) is externally grounded. By this means, an external printer or digital voltmeter can inhibit reset until its cycle of operation has been completed.

9-9 The ground potential which occurs at terminal C (P302) when Q7 turns on may be used as the print command signal to initiate the operating cycle of an external printer.

9-10 Inhibit Signal. Note that the output of Q13 triggers a one shot Q8/Q9 the output of which inhibits the start input through CR9 until the one-shot returns to its normal condition after approximately 20 milliseconds delay. This action assures that no start pulse will open the gate until all circuits in the counter are reset.

9-11 The PNP transistors in the decade units are reset by the output of Q35. Q13 inverts the signal to produce the NPN Reset output at the collector of Q36. Q16 reset output drives the two decades in the Reset and Display circuit. The reset signal is also applied to a second one-shot Q33/Q34 which inhibits the input to the X10 decade until reset action is complete throughout the X10 and X100 Decades.

9-12 X10 and X100 Decades. These two circuits are essentially identical to the typical decade units described in Section 8. Refer to that section of the manual for circuit details.

9-13 In all positions of the Function Selector except the X100 functions, the input to the X100 decade is the 10 cps time base signal. This circuit, therefore, produces the 1 cps time base at the output. In all functions except X10 and X100, the 1 cps output of the X100 decade is applied to the X10 decade which produces the 0.1 cps time base outputs. Note that these decades are reset to "9" so that each will produce an output pulse when the first input pulse is received.

9-14 In the X10 or X100 positions, the input signal used for gating passes through one or both decades so that the gating interval is extended 10 or 100 times.

9-15 Servicing Guide. When servicing the Display and Reset board, first confirm that start and stop pulses are available at the input terminals. If no Gate level signal at terminal F (P301) occurs with start and stop pulses applied, check transistors Q3 through Q6 and associated components. Make a methodical check for presence of all output signals represented by the waveforms in Figure 9-1

9-16 If the X10 or X100 decade section is mal-functioning, refer to the "Decade" circuit description and trouble symptom guide.

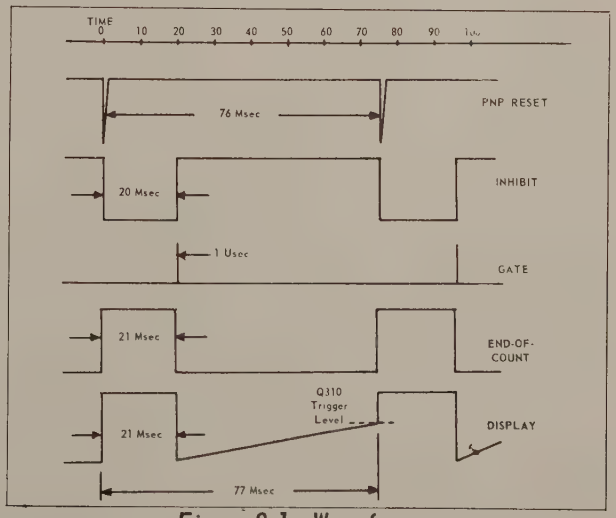
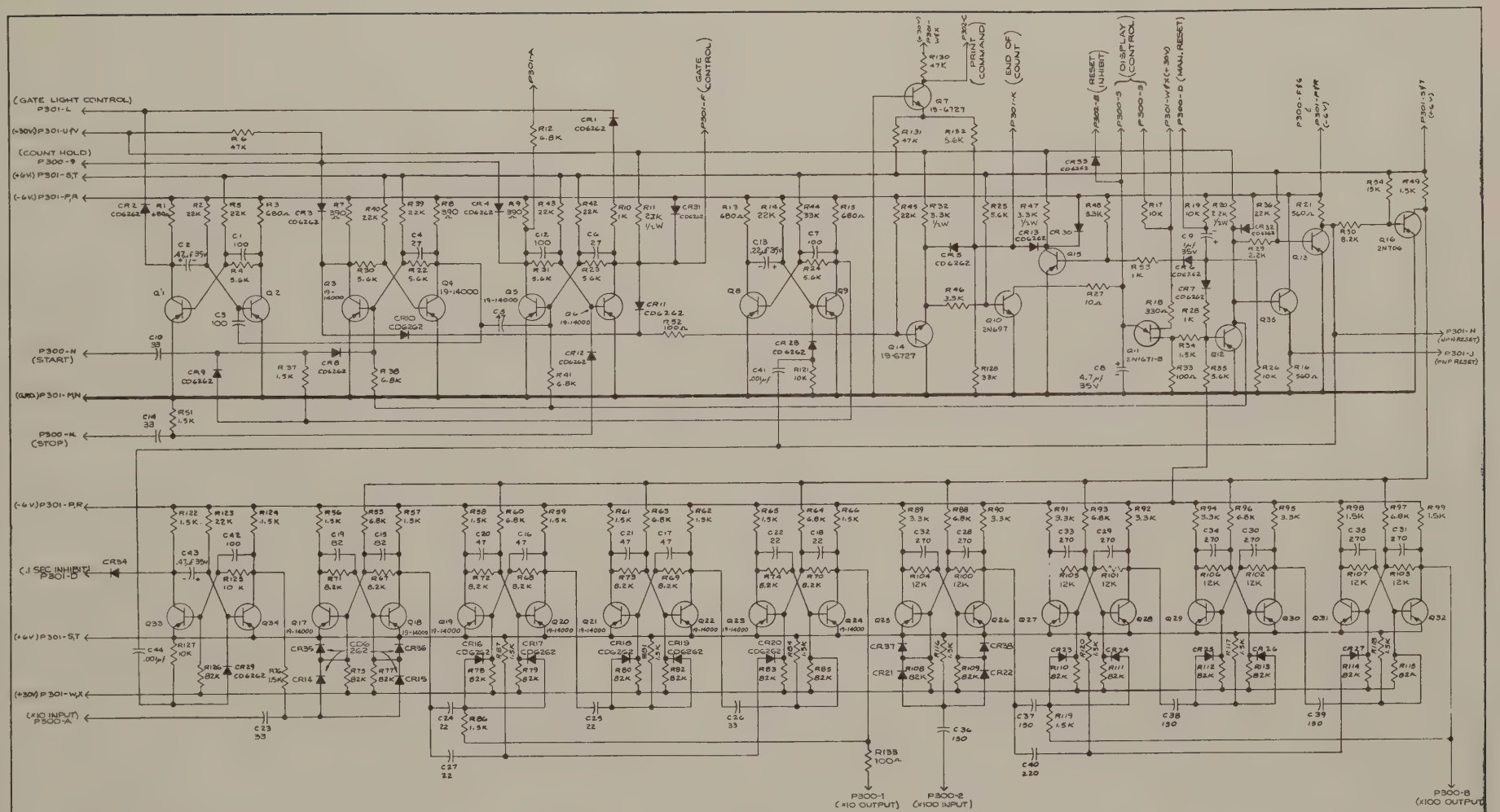


Figure 9-1 Waveforms
(Shown for 1 microsecond time base in TEST function with Display control at fastest rate.)



6. TRANSISTORS 19-14000 & 19-6727 ARE PER SYSTRON-DONNER DWGS 14000 & 6727.
5. ALL TRANSISTORS ARE 19-15700 PER SYSTRON-DONNER DWG Nº 15700.
4. DIODES PER SYSTRON-DONNER DWG. 6700.
3. CAPACITOR VALUES ARE IN pf.
2. ALL CAPACITORS ARE 50V MIN., ± 10% EXCEPT C 2,9,13 & 43 ARE 35V, ±20%.
1. ALL RESISTORS ARE ± 5%, 1/4W, CARBON.

UNLESS OTHERWISE SPECIFIED,

NOTES:

DRAWN BY JENNINGS	DATE 9/21/64	UNLESS SPECIFIED DIMENSIONS INCHES			
CHECKED BY	DATE	TOLERANCES			
ENGR'G APPR'D	DATE	DECIMAL			
APPROVED BY	DATE	ANGULAR			
		SURFACE FINISH	DET NO	ITEM	MATERIAL
MODEL	NEXT ASSEM				
		SCALE			
1037M-2 1037	1539I 1539I	TITLE SCHEMATIC, DISPLAY / RESET		DWG NO 14881	ISSUE

SYSTRON DONNER CONCORD CALIFORNIA

Table 9-1 Display and Reset Parts List

CAPACITORS

Schem. Ref.	Illus. Index	S-D Part
C1	B5	C-0628
C2	A5	C-0733
C3	B6	C-0628
C4	C5	C-0530
C5	C6	C-0533
C6	D5	C-0530
C7	B4	C-0628
C8	B7	C-0406
C9	A7	C-0524
C10	B6	C-0531
C12	C5	C-0628
C13	A4	C-0354
C14	D6	C-0531
C15	D3	C-0535
C16	C3	C-0533
C17	B3	C-0533
C18	A3	C-0529
C19	D3	C-0535
C20	C3	C-0533
C21	B3	C-0533
C22	A3	C-0529
C23	D2	C-0531
C24	D3	C-0529
C25	C3	C-0529
C26	B3	C-0531
C27	A2	C-0529
C28	A1	C-0539
C29	B1	C-0539
C30	C1	C-0539
C31	D1	C-0539
C32	A1	C-0539
C33	B1	C-0539
C34	C1	C-0539
C35	D1	C-0539
C36	A2	C-0537
C37	B1	C-0537
C38	B1	C-0537
C39	C1	C-0537
C40	D1	C-0538
C41	A4	C-0235
C42	C4	C-0628
C43	D4	C-0733
C44	A4	C-0235

DIODES

Schem. Ref.	Illus. Index	S-D Part
CR1	D5	CR-0150
CR2	B5	CR-0150
CR3	C6	CR-0150
CR4	C6	CR-0150
CR5	B6	CR-0150
CR6	A6	CR-0150
CR7	A7	CR-0150
CR8	B5	CR-0150
CR9	B5	CR-0150
CR10	C5	CR-0150
CR11	C5	CR-0150
CR12	D5	CR-0150
CR13	A6	CR-0150

DIODES

Schem. Ref.	Illus. Index	S-D Part
CR14	D3	CR-0150
CR15	D3	CR-0150
CR16	C3	CR-0150
CR17	C3	CR-0150
CR18	B3	CR-0150
CR19	B3	CR-0150
CR20	A3	CR-0150
CR21	A1	6-6700
CR22	A1	6-6700
CR23	B1	6-6700
CR24	B1	6-6700
CR25	C1	6-6700
CR26	C1	6-6700
CR27	D1	6-6700
CR28	A4	CR-0150
CR29	B4	CR-0150
CR30	A6	6-6700
CR31	D5	CR-0150
CR32	A7	CR-0150
CR33	A4	CR-0150
CR34	B4	6-6700
CR35	D2	CR-0150
CR36	D3	CR-0150
CR37	A1	6-6700
CR38	A1	6-6700

TRANSISTORS

Schem. Ref.	Illus. Index	S-D Part
Q1	B5	15700
Q2	B5	15700
Q3	C5	14000
Q4	C5	14000
Q5	D5	14000
Q6	D5	14000
Q7	B5	6727
Q8	B5	15700
Q9	B4	15700
Q10	B7	Q-0028
Q11	B7	Q-0084
Q12	A7	15700
Q13	A7	15700
Q14	B7	6727
Q15	A7	15700
Q16	A6	Q-0130
Q17	D3	14000
Q18	D3	14000
Q19	C3	14000
Q20	C3	14000
Q21	B3	14000
Q22	B3	14000
Q23	A3	14000
Q24	A3	14000
Q25	A1	1570(
Q26	A1	15700
Q27	B1	15700
Q28	B1	15700
Q29	C1	15700
Q30	C1	15700
Q31	D1	15700
Q32	D1	15700
Q33	C4	15700
Q34	D4	15700
Q35	D6	15700

RESISTORS

Schem. Ref.	Illus. Index	S-D Part
R1	B5	R-1234
R2	B5	R-0768
R3	B5	R-1234
R4	A5	R-0821
R5	A5	R-0768
R6	C6	R-0777
R7	C6	R-0880
R8	C6	R-0880
R9	D6	R-0880
R10	D5	R-0765
R11	C5	R-0143
R12	D6	R-0696
R13	B5	R-1234
R14	B4	R-0768
R15	B4	R-1234
R16	D5	R-0814
R17	B7	R-0766
R18	B7	R-0662
R19	A7	R-0766
R20	D6	R-0259
R21	A7	R-0819
R22	C5	R-0821
R23	D5	R-0821
R24	B4	R-0821
R25	B6	R-0821
R26	A6	R-0766
R27	B7	R-0739
R28	A7	R-0765
R29	A7	R-0721
R30	B5	R-0821
R31	C5	R-0821
R32	C6	R-0136
R33	B7	R-0966
R34	B7	R-0783
R35	A7	R-0821
R36	A6	R-0768
R37	B5	R-0783
R38	C6	R-0696
R39	C5	R-0768
R40	B5	R-0768
R41	D6	R-0696
R42	D6	R-0768
R43	C5	R-0768
R44	A5	R-0780
R45	B6	R-0768
R46	B6	R-0720
R47	B6	R-0136
R48	A6	R-0720
R49	A6	R-0783
R50	A5	R-0883
R51	D5	R-0783
R52	C6	R-0966
R53	A6	R-0765
R54	A6	R-728
R55	D2	R-0696
R56	D2	R-0783
R57	D2	R-0783
R58	C2	R-0783
R59	C2	R-0783
R60	C2	R-0696
R61	B2	R-0783
R62	B2	R-0783
R63	B2	R-0696
R64	A2	R-0696
R65	A2	R-0783
R66	A3	R-0783
R67	D3	R-0883
R68	C3	R-0883
R69	B3	R-0883
R70	A3	R-0883
R71	D3	R-0883
R72	C2	R-0883
R73	B2	R-0883
R74	B2	R-0883
R75	D2	R-0784
R76	D3	R-0783
R77	D2	R-0784
R78	C2	R-0784
R79	C2	R-0784
R80	B2	R-0784
R81	B3	R-0783
R82	B2	R-0784
R83	A2	R-0784
R84	B3	R-0783
R85	B2	R-0784
R86	C3	R-0783
R87	A3	T-0783
R88	A2	R-0696
R89	A2	R-0720
R90	B2	R-0720
R91	B2	R-0720
R92	B2	R-0720
R93	B2	R-0696
R94	C2	R-0720
R95	C2	R-0720
R96	C2	R-0696
R97	D2	R-0696
R98	D2	R-0783
R99	D1	R-0783
R100	B1	R-0759
R101	B1	R-0759
R102	C1	R-0759
R103	D1	R-0759
R104	A1	R-0759
R105	B1	R-0759
R106	C1	R-0759
R107	D1	R-0759
R108	A2	R-0784
R109	A2	R-0784
R110	B2	R-0784
R111	B2	R-0784
R112	C2	R-0784
R113	C2	R-0784
R114	D2	R-0784
R115	D2	R-0784
R116	A1	R-0783
R117	C1	R-0783
R118	B1	R-0783
R119	B1	R-0783
R120	D1	R-0783
R121	B4	R-0766
R122	C4	R-0783
R123	A4	R-0768
R124	A4	R-0783
R125	D4	R-0766
R126	D4	R-0784
R127	B4	R-0766
R128	B6	R-0780
R130	B4	R-0777
R131	B4	R-0777
R132	C5	R-0821
R133	A4	R-0966
R134		R-0766

MISCELLANEOUS

P.C. Board	14418
stiffener silk-screen ass'y	15571
P.C. Board stiffener	·9669
Nylon Bushing	H-0941
Drive rivet #38-104-06-13	H-0940

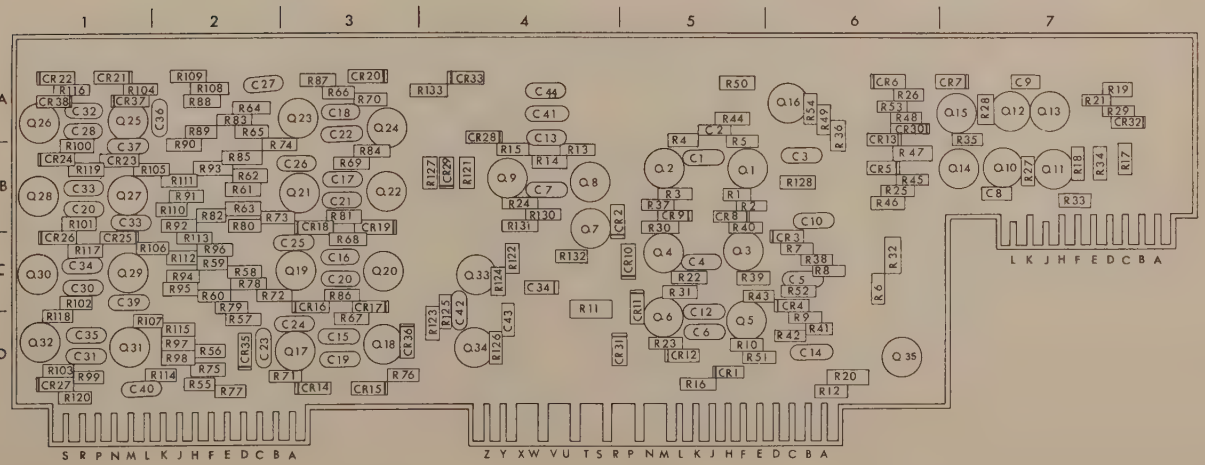


Figure 9-3 Display and Reset Parts Location Detail, Assy. 15391

10 — DECIMAL COUNTING UNITS
10MC, 2.5MC, 250KC DECADES

10-1 BASIC DECADE UNIT

10-2 General. The following description is based upon the 250 Kc decade which uses NPN type transistors resulting in the voltage polarities 10MC. The 25 Kc decades use PNP transistors and therefore all polarities are reversed. The differences between these decades are described in subsequent paragraphs.

10-3 The basic decade or decimal counting unit consists of four binaries which operate in a chain to produce one output pulse for every ten input pulses. At the same time, ten discreet states of collector voltage levels of the four binaries are obtained to produce a scale-of-ten or binary-coded decimal output.

10-4 Each binary is triggered into one of two stable states by negative input pulses. In the "1" state, the left or odd-numbered transistor (relative to the schematic) conducts and the binary output level at the collector of the non-conducting transistor is -6 volts ("-" level). In the "0" state, the opposite condition exists and the output is 0 volts ("+" level). In the simplified diagram of Figure 10.1, the shaded areas indicate which transistors in the decade are conducting at the reset condition. The binary logic is 0-0-0-0, which is equivalent to a coded "0". (The X1-X10 decade in the Display and Reset circuit resets to "9"; all other reset to "0").

10-5 The first three binaries have dual mode triggering through the parallel input steering diode connections and therefore change from one state to another on receiving successive negative pulses from the preceding stage or decade input. In dual mode triggering, one steering diode is cutoff by the -6 volts at the collector of the non-conducting transistor. The negative input pulse passes through the other steering diode and cuts off the conducting transistor. The following negative pulse will not pass through the same diode because of the reversal of biasing. Binary A alternates with every input pulse or "count," Binary B with every second count (when not inhibited), and Binary C with every fourth count. Binary D has two single-mode trigger inputs: a) the output of Binary A, being coupled to the even numbered transistor, will cause it to trigger to the "0" state only; b) similarly, the positive output of Binary C, being coupled to the odd-numbered transistor, will cause it to trigger to the "1" state only. A third special condition exists at the input to Binary B: c) Feedback from the output of Binary D through R610 and the normal input through C604 form an AND gate. A positive input will pass only if the output of Binary D is negative. On counts 8 and 9, the output is positive, which prevents the next negative pulse from passing through the gate. Therefore, Binary B is inhibited from triggering at count "0". The complete sequence of events is shown in Figure 10-3. The arrows in the illustration indicate the triggering modes discussed above.

10-6 1-2-4-8 Binary-Coded Decimal Output. The -6 volt or 0 volt binary output levels corresponding to the logic scheme in Figure 10-1 constitute a 1-2-4-8 binary code for the 0 to 9 count cycle. These voltages, as obtained from the collector of the left PNP or right NPN transistor of each binary (with reference to their location on the schematic) are used directly as the binary-coded decimal output at terminals F, H, J, and K of connector (J402, J502, J602, etc.) limit the negative level of the output to -6 volts.

10-7 Bi-Quinary Drive Circuit. Bi-quinary circuit logic is used in the indicator drive circuit associated with each decade counting unit in the Counter. The circuit consists of a binary stage which alternately energizes the even-numbered and odd-numbered anodes in the indicator with successive input pulses, and a "scale of five" circuit consisting of five transistors

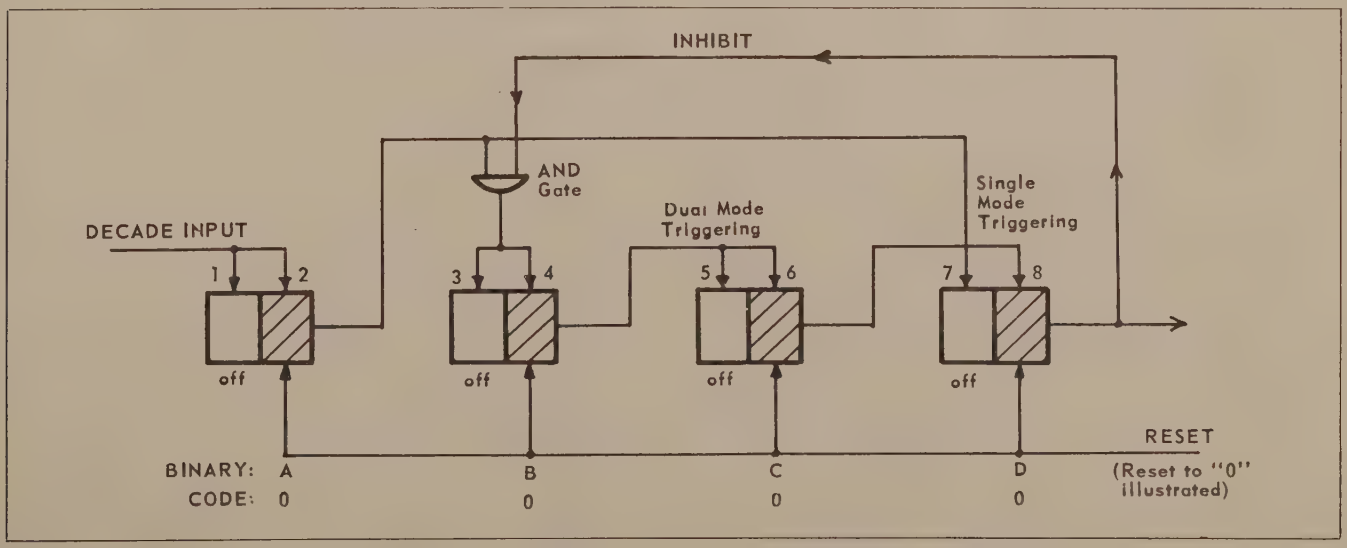


Figure 10-1 Simplified Diagram of NPN Decade Unit (250 K)

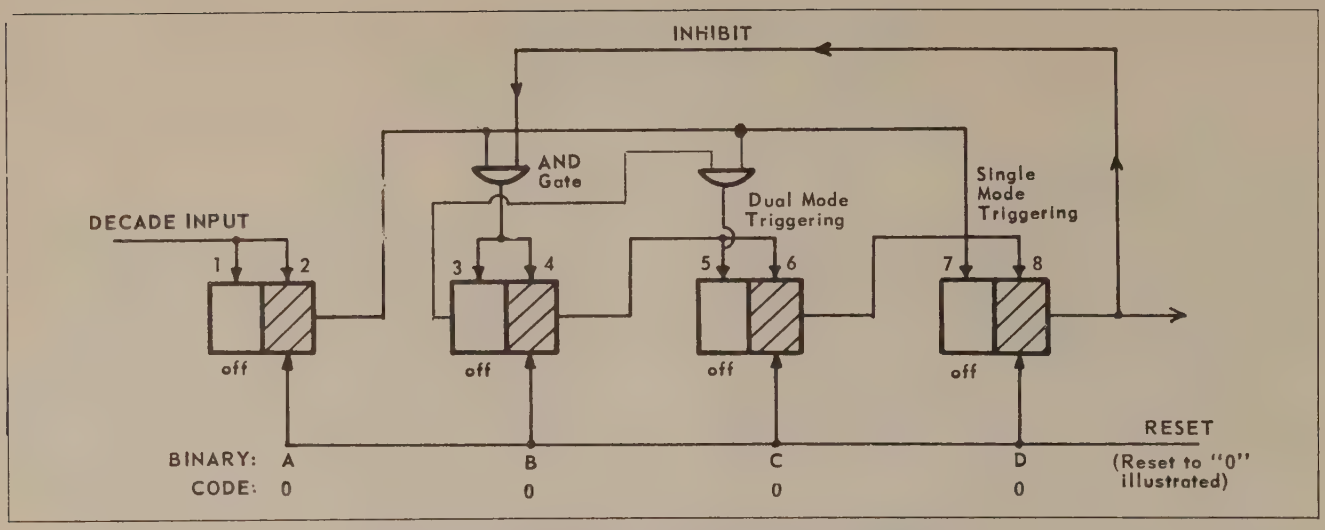


Figure 10-2 Simplified Diagram of PNP Decade Unit

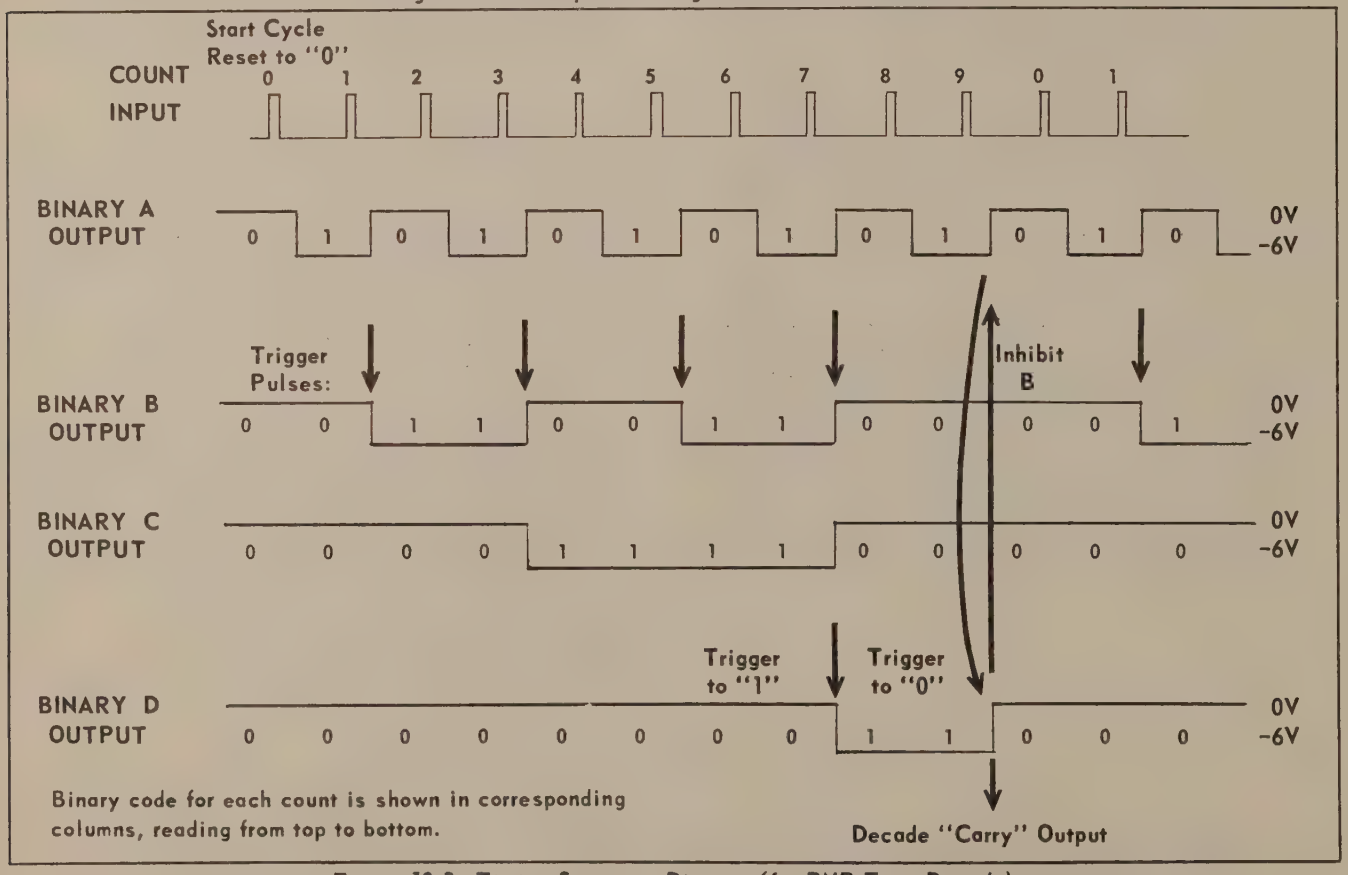

Start Cycle Reset to "0"
COUNT
INPUT
0 1 2 3 4 5 6 7 8 9 0 1
BINARY A OUTPUT
0 1 0 1 0 1 0 1 0 1 0 1 0
0V
-6V
Trigger Pulses:
Inhibit B
BINARY B OUTPUT
0 0 1 1 0 0 1 1 0 0 0 0 1
BINARY C OUTPUT
0 0 0 0 1 1 1 1 0 0 0 0 0
Trigger to "1"
Trigger to "0"
BINARY D OUTPUT
0 0 0 0 0 0 0 0 1 1 0 0 0
Binary code for each count is shown in corresponding columns, reading from top to bottom.
Decade "Carry" Output

Figure 10-3 Timing Sequence Diagram (for PNP Type Decade)

Table 10-1 Scale of 5

Count	Binary Output Code		
	D_0	C_0	B_0
0,1	0	0	0
2,3	0	0	1
4,5	0	1	1
6,7	0	1	0
8,9	1	0	0

Table 10-2 Circuit Connections

Transistor	Input Connections		
Q511	D_0	C_0	B_0
Q512		C_0	B_1
Q513		C_1	B_1
Q514		C_1	B_0
Q515	D_1		

which turn on successively for a duration of two input pulses or "counts". Each of the 5 transistors control an odd and an even-numbered cathode in the indicator in the sequence of 0-1, 2-3, 4-5, 6-7, 8-9. The combined action of the binary and quinary circuits, therefore, produces the desired scale of 10.

10-8 The bi-quinary circuit is driven by the output voltages of the "8421" binaries of the basic decade unit. The "1's" or A binary of the decade drives the two transistors in the binary section of the bi-quinary circuit directly (Q500 and Q501 on drawing 10364). These turn on and off corresponding drivers Q519 and Q520 which ignite the indicator anodes. The quinary section is driven by the B, C, and D binaries, the normal outputs of which form a scale of 5 as shown in Table 10-1.

10-9 Each transistor in the quinary section is controlled by AND gate logic. If all inputs are 0 volts (equivalent to a logical 0), the transistor will turn on and cause the corresponding even or odd indicator numeral to energize. If one input is -6 volts (equivalent to logical "1") the transistor will turn off.. The input connections for each transistor in the quinary section can be deduced from Table 8.1. Where a "0" occurs in the code for a particular numeral, the normal output from the binary is used: B_0, C_0 and D_0. Where "1" occurs in the code, this is transformed to a "0" to satisfy the necessary input condition for "on" state by employing the alternate output of opposite phase of each binary: B_1, C_1 and D_1. Table 8.2 shows the actual input connection scheme, which eliminates redundant combinations.

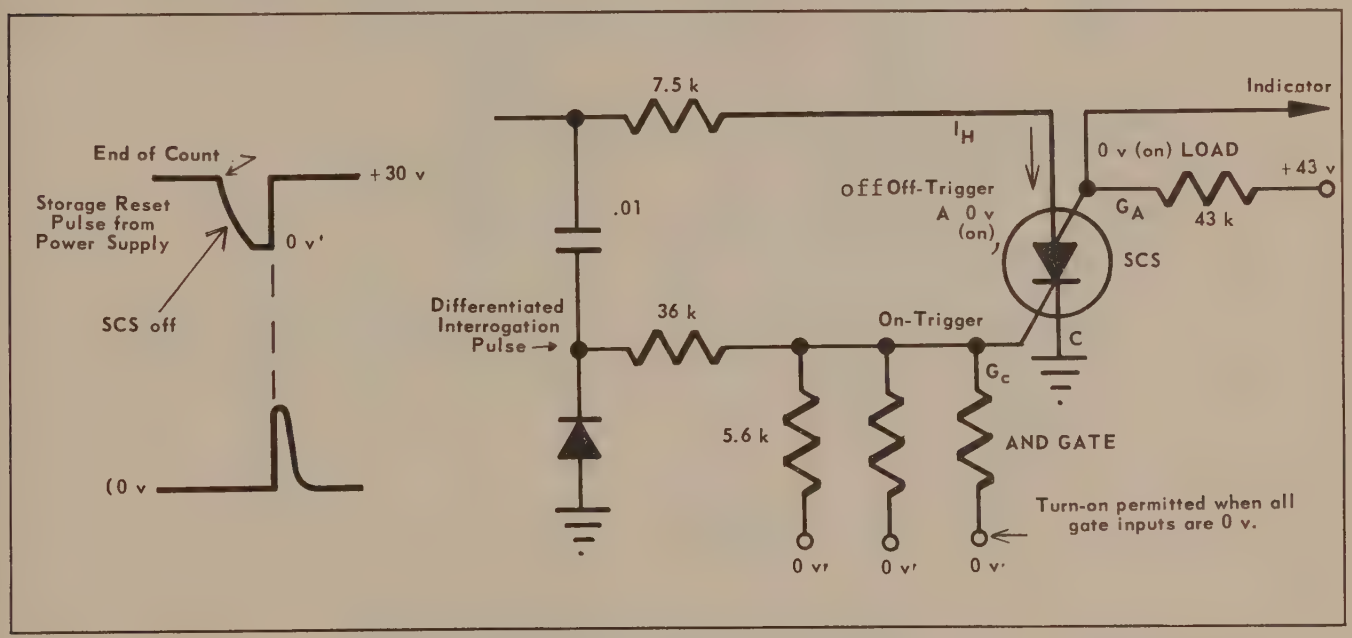


Figure 10-4 Storage Input Circuit and Waveforms

10-10 STORAGE DECADES (Option S)

10-11 The storage type decade units employ Silicon-Controlled Switches (SCS) in place of transistors in the Bi-quinary drive circuitry. These SCS's require a special trigger input in addition to the normal "And" gate inputs present before they will switch on and cause the corresponding numeral to indicate. The storage input circuit is shown in Figure 10-4. The "Storage Reset" waveform generated in the power supply at end-of-count is applied at terminal E. The negative-going edge of the pulse is coupled through the 7.5K resistor to the anodes of all the SCS's, turning them off, which removes the numeral display. The positive-going portion of the pulse, occuring less than 500 microseconds later, is differentiated by the .01 mfd capacitor into the sharp interrogation pulse also shown in Figure 10-4 This pulse is applied to the cathode gate (G_c) of each SCS, turn them on.

10-12 Once the SCS is turned on, its holding characteristics will keep it turned on, regardless of how the quinary gating signals may change. The indicator, therefore, will hold the count which has occurred at the end-of-count signal and will not indicate subsequent counts until the following end-of-count pulse.

10-13 2.5 MC DECADE

10-14 The 2.5MC decade departs from the basic scheme described above in the following manner. In order to reduce capacitive loading which causes distortion of the square-wave needed for triggering at high frequencies, an emitter follower stage, Q507, is inserted at the output of Binary A. For the same reason, single mode triggering is used for Binary C. Binary B output, therefore, triggers Binary C to the "1" state on count 4 by coupling through C511 to Q517. Binary C is triggered back to the "0" state by output of Binary A taken at the collector of Q506 and emitter follower output which coupled through on And gate to Q510 (C512 and CR513 paths).

10-15 Binary A (Q505 Q506) uses two extra diodes, CR503 and CR501, which provide DC restoring action to RC networks C505, R511 and C506, R512. This additional circuitry, together with the type of transistor used, improves the speed of response of the binary to accept 2.5 MC frequencies from the 10MC decade. CR508 in the "inhibit" path serves a similar purpose. The output polarity of the 2.5MC decade is inverted through Q521 to provide the correct polarity to operate the following 250KC NPN type decade unit. All binaries and gates are sensitive to positive input pulses

10-16 10 MC DECADE

10-17 This 10MC decade unit is essentially identical to the 2.5MC decade except for differences in component values. No output inverter stage is needed to drive the following PNP type decade.

10-18 DECADE UNIT SERVICING GUIDE

10-19 The following trouble-shooting guide refers to circuit detail numbers in the 2.5MC de cade. By transposing the transistor reference numbers, it may also be applied to the 10MC, 250KC, and X10 decades. The 10MC decade symptoms will not correspond fully to those listed. The symptoms may occur somewhat less predictably than presented in the table.

A transistor may not conduct, for example, because it is open, the complementary transistor is leaky, or the associated steering diode is open.

Table 10-3 Decade Units Trouble Symptoms Guide

(Detail numbers refer to 2 5 MC decade.)

	Symptom	Causes
a.	Reads out even numbers only	Q520 or Q500
b.	Reads out odd numbers only	Q519 or Q501
c.	Locks on any even or odd number	Q505 or Q506
d.	Alternates between 0 and 1	Q507, 508, 509, 512 or 513
e.	Alternates between 2 and 3 (See "f" and "g" below)	Q508 or Q509
f.	Cycles: 0-1-2-3. or alternates: 2 and 3 . . .	Q510 or Q511
g.	Cycles: 0 through 7, or alternates: 2 & 3 or 6 & 7	Q512 or Q513
h.	Alternates with dual illumination: 0 1, 2 3, 4 5, 6 7, 8 9, etc.	Q500, 501, 519, or 520
i.	Two numbers indicate simultaneously	Leaky bi-quinary drive transistor related to numeral which is out of sequence.

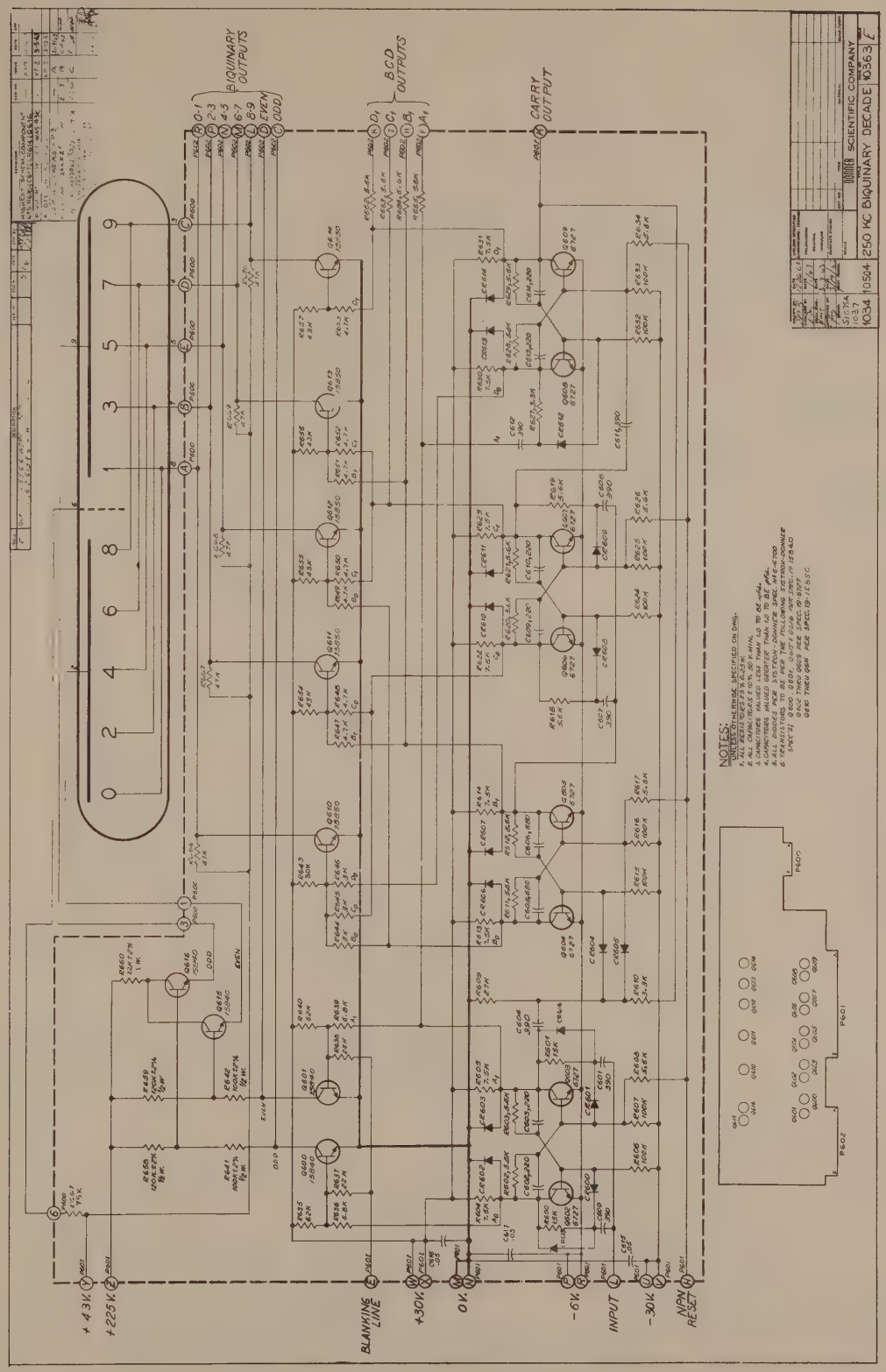
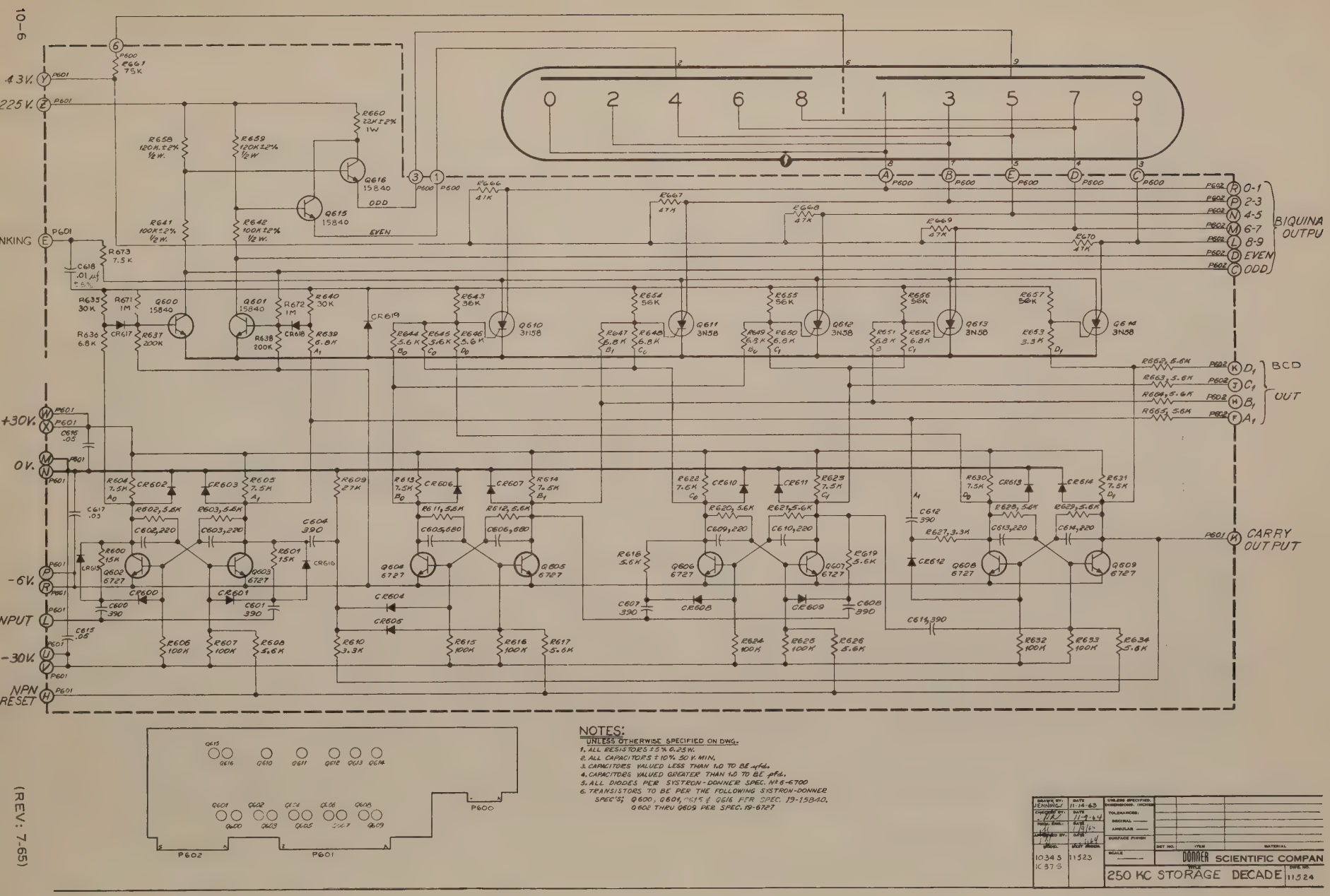


Figure 10-5 250 Kc Standard Decade Schematic No. 10363



NOTES:
UNLESS OTHERWISE SPECIFIED ON DWG.
1. ALL RESISTORS ±5% 0.25W.
2. ALL CAPACITORS ± 10% 50 V. MIN.
3. CAPACITORS VALUED LESS THAN 1.0 TO BE μfd.
4. CAPACITORS VALUED GREATER THAN 1.0 TO BE μfd.
5. ALL DIODES PER SYSTRON-DONNER SPEC. NO 6-6700
6. TRANSISTORS TO BE PER THE FOLLOWING SYSTRON-DONNER SPEC'S; Q600, Q601, Q615 & Q616 PER SPEC. 19-15840, Q602 THRU Q609 PER SPEC. 19-6727

DRAWN BY: JENNINGS	DATE 11-14-63	UNLESS SPECIFIED: DIMENSIONS: INCHES	
CHECKED BY: [illegible]	DATE 11-14-64	TOLERANCES: DECIMAL —— ANGULAR ——	
PROJ. ENGR. [illegible]	DATE 11-16-64	SURFACE FINISH	
APPROVED BY [illegible]	DATE 11-16-64	SCALE ——	SET NO. / ITEM / MATERIAL
PROJ. 10345 IC 373	STOCK NUMBER 11523		DONNER SCIENTIFIC COMPAN
		TITLE 250 KC STORAGE DECADE	DWG. NO. 11524

(REV: 7-65)

Figure 10-6 250 Kc Storage Decade Schematic No. 11524

Table 10-4 250 Kc Decade Composite Parts List

CAPACITORS

Schem. Ref.	Illus. Index	S-D Part
C600	C2	C-0541
C601	C3	C-0541
C602	B3	C-0538
C603	B3	C-0538
C604	C3	C-0541
C605	A4	C-0638
C606	A4	C-0638
C607	C4	C-0541
C608	C5	C-0541
C609	B5	C-0538
C610	B5	C-0538
C611	C6	C-0541
C612	C6	C-0541
C613	B6	C-0538
C614	B6	C-0538
C615	C2	C-0708
C616	C2	C-0708
C617	C2	C-0708
C618	C6	C-0705

DIODES

CR600	C3	6700
CR601	C3	6700
CR602	B2	6700
CR603	B3	6700
CR604	C4	6700
CR605	C4	6700
CR606	B3	6700
CR607	A4	6700
CR608	C5	6700
CR609	C6	6700
CR610	B5	6700
CR611	B5	6700
CR612	C6	6700
CR613	B6	6700
CR614	B6	6700
CR615	C2	6700
CR616	C3	6700
CR617 S	B2	6700
CR618 S	B2	6700
CR619 S	A6	6700

MISCELLANEOUS

P. C. Board	11525
P. Silkscreen Ass'y	15375
P. C. Bd. Stiffener	1-9669
Nylon Bushing	H-0941
Drive Rivet	H-0940

RESISTORS

Schem. Ref.	Illus. Index	S-D Part		
R600	C2	R-0728		
R601	C3	R-0728		
R602	B3	R-0821		
R603	B3	R-0821		
R604	B2	R-0884		
R605	B3	R-0884		
R606	C5	R-0741		
R607	C3	R-0741		
R608	C3	R-0821		
R609	B3	R-0824		
R610	C4	R-0742		
R611	A4	R-0821		
R612	A4	R-0821		
R613	B3	R-0884		
R614	A4	R-0884		
R615	C4	R-0741		
R616	C4	R-0741		
R617	C4	R-0821		
R618	C5	R-0821		
R619	C6	R-0821		
R620	B5	R-0821		
R621	B5	R-0821		
R622	A4	R-0884		
R623	B6	R-0884		
R624	C5	R-0741		
R625	C5	R-0741		
R626	C5	R-0821		
R627	C6	R-0742		
R628	B6	R-0821		
R629	B6	R-0821		
R630	B6	R-0884		
R631	B6	R-0884		
R632	C6	R-0741		
R633	C6	R-0741		
R634	C6	R-0821		
R635	B2	R-0971 N	R-0715 S	
R636	B2	R-0696 N	R-0715 S	
R637	B2	R-0768 N	R-0823 S	
R638	B2	R-0768 N	R-0823 S	
R639	B2	R-0696		
R640	B2	R-0971 N	R-0785 S	
R641	A1	R-01498		
R642	A1	R-01498		
R643	A2	R-0715		
R644	A3	R-0711 N	R-0821 S	
R645	A2	R-0711 N	R-0821 S	
R646	A2	R-0711 N	R-0[illegible] S	
R647	A3	R-0892	R-0696	
R648	A3	R-0892	R-0696 S	
R649	A4	R-0892 N	R-0696	
R650	A4	R-0892	R-0696	
R651	A5	R-0892	R-0696	
R652	A5	R-0892	R-0696	
R653	A6	R-0892	R-0742	
R654	A3	R-0695		
R655	A4	R-0695	R-1235	
R656	A5	R-0695 N	R-1235 S	
R657	A6	R-0695	R-1235	
R658	A1	R-01499		
R659	A1	R-01499		
R660	A1	R-01596		
R661	A2	R-0976		
R662	A6	R-0821		
R663	A4	R-0821		
R664	A3	R-0821		
R665	B1	R-0821		
R666	B1	R-0777		
R667	B1	R-0777		
R668	B1	R-0777		
R669	B1	R-0777		
R670	B1	R-0777		
R671 S	B2	R-0962		
R672 S	B2	R-0962		
R673 S	A6	R-0821		

TRANSISTORS

Q600	B2	15840
Q601	B2	15840
Q602	B3	6727
Q603	B3	6727
Q604	B4	6727
Q605	B4	6727
Q606	B5	6727
Q607	B5	6727
Q608	B6	6727
Q609	B6	6727
Q610	A3	15850 Q-0136
Q611	A4	15850 Q-0136
Q612	A5	15850 N Q-0136 S
Q613	A6	15850 Q-0136
Q614	A6	15850 Q-0136
Q615	A2	15840
Q616	A2	15840

*Applicable to:
Standard Board No. 1050
S Option Board No. 1152

NOTES:*
1–Components not marked N or S are on all boards regardless of option:
2–Components marked N are on non-storage option boards only:
3–Components marked S are on storage option boards only:
4–Refer to Master Parts List (Section 13) for component description:

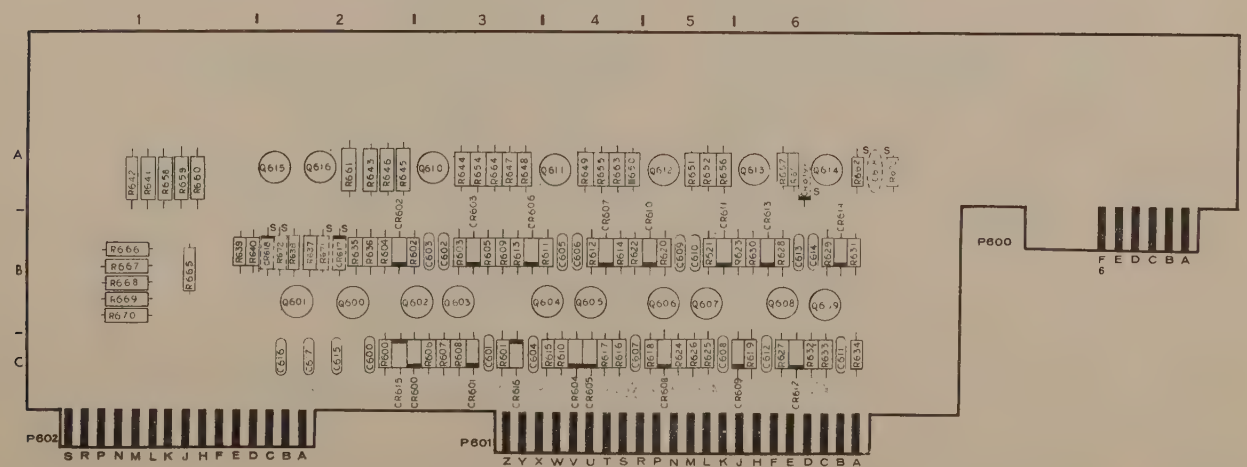


Figure 10-7 250 Kc Decade Composite Parts Location Detail, Assy. 10504 (Std) Assy. 11523 (Storage)

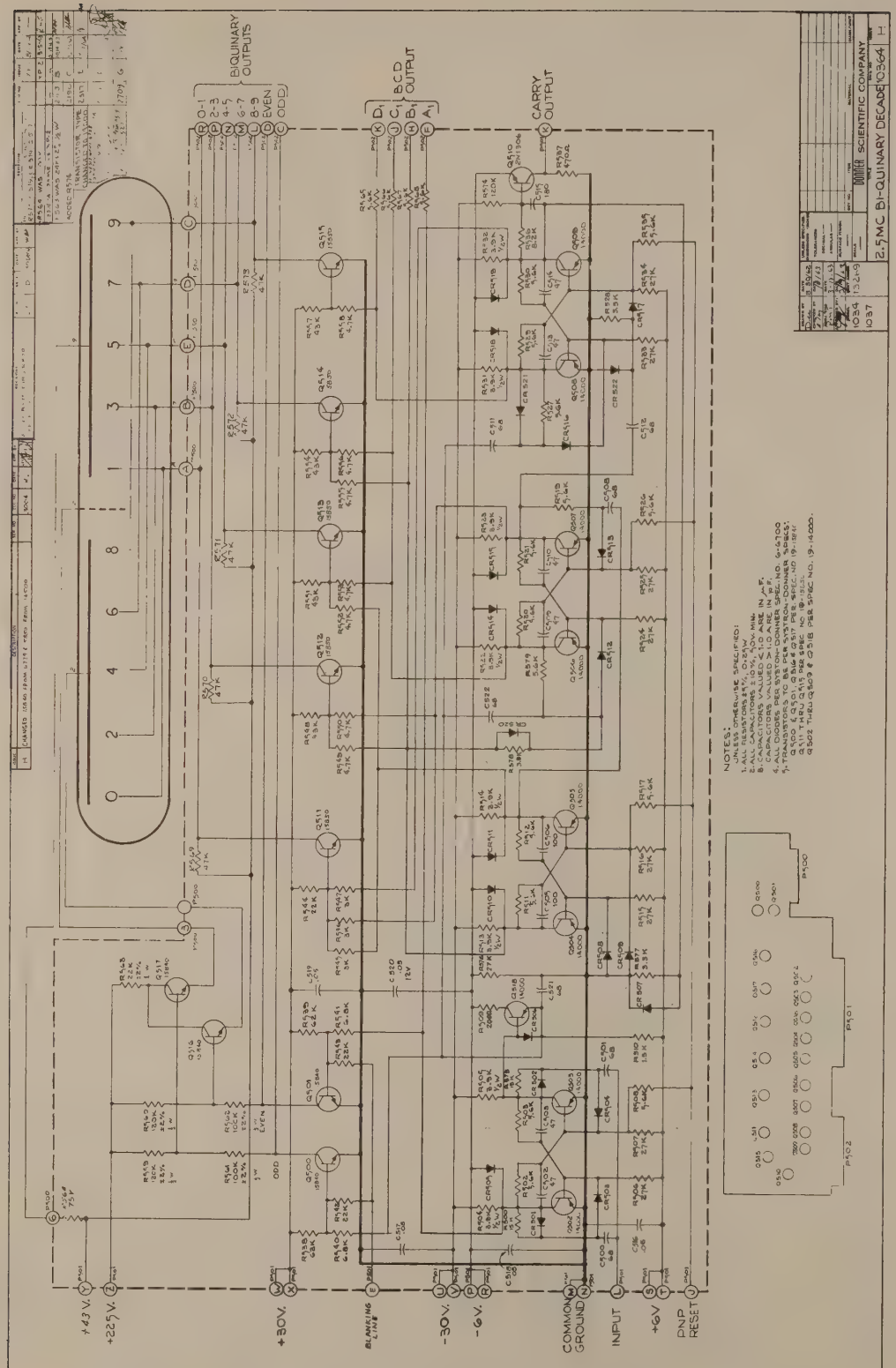


Figure 10-8 2.5 Mc Standard Decade Schematic No. 10364

Table 10-5 2.5 Mc Bi-quinary Decade Parts List

Schem Ref.	Illus Index	S-D Part
CAPACITORS		
C500	C6	C-0635
C501	C5	C-0635
C502	B5	C-0533
C503	B5	C-0533
C505	B4	C-0536
C506	B4	C-0536
C508	C4	C-0635
C509	B3	C-0533
C510	B3	C-0533
C511	C3	C-0635
C512	C3	C-0635
C513	B2	C-0533
C514	B2	C-0533
C515	B1	C-0643
C516	C2	C-0708
C517	C1	C-0708
C518	C1	C-0708
C519	C1	C-0708
C520	B5	C-0672
C521	C5	C-0635
C522	C3	C-0635

Schem. Ref.	Illus Index	S-D Part.
DIODES		
CR501	B7	6700
CR502	B6	6700
CR503	C7	6700
CR504	C6	6700
CR505	B7	6700
CR506	C6	6700
CR507	C5	6700
CR508	C5	6700
CR509	C5	6700
CR510	B5	6700
CR511	B4	6700
CR512	C4	6700
CR513	C3	6700
CR514	B4	6700
CR515	B3	6700
CR516	C3	6700
CR517	C2	6700
CR518	B3	6700
CR519	B1	6700
CR520	C5	6700
CR521	B2	6700
CR522	C1	6700

Schem. Ref.	Illus. Index	S-D Parts
TRANSISTORS		
Q500	A8	15840
Q501	A8	15840
Q502	C6	14000
Q503	C5	14000
Q504	C4	14000
Q505	C4	14000
Q506	C3	14000
Q507	C3	14000
Q508	C2	14000
Q509	C2	14000
Q510	B1	Q-0075
Q511	A2	14500
Q512	A5	14500
Q513	A3	14500
Q514	A4	14500
Q515	A1	14500
Q516	A6	15840
Q517	A5	15480
Q518	C5	14000

Schem. Ref.	Illus. Index	S-D Parts
RESISTORS		
R500	B6	P/N0728
R502	B6	R-0821
R503	C6	R-0821
R504	B6	R-0616
R505	B5	R-0616
R506	C6	R-0824
R507	C6	R-0284
R508	C6	R-0821
R509	B5	R-0736
R510	B5	R-0783
R511	B4	R-0921
R512	B4	R-0821
R513	B4	R-0616
R514	B4	R-0616
R515	C5	R-0824
R516	C4	R-0824
R517	C4	R-0821
R519	C3	R-0821
R520	B3	R-0821
R521	B3	R-0821
R522	A3	R-0616
R523	B2	R-0616
R524	C3	R-0824
R525	C3	R-0824
R526	C3	R-0821
R527	B2	R-0821
R528	C1	R-0742
R529	B1	R-0821
R530	B2	R-0821
R531	B2	R-0616
R532	B1	R-0616
R533	C2	R-0824
R534	C2	R-0824
R535	C2	R-0821
R536	B1	R-0883
R537	C1	R-1044
R538	A8	R-0971
R539	A7	R-0971
R540	A8	R-0696
R541	A7	R-0696
R542	A8	R-0768
R543	A7	R-0768
R544	A2	R-0715
R545	A3	R-0711
A546	A3	R-0711
R547	A2	R-0711
R548	A5	R-0695
R549	A5	R-0892
R550	A5	R-0892
R551	A3	R-0695
R552	A3	R-0892
R553	A4	R-0892
R554	A4	R-0695
R555	A4	R-0892
R556	A4	R-0892
R557	A2	R-0695
R558	A2	R-0892
R559	A6	R-1499
R560	A6	R-1499
R561	A6	R-1498
R562	A6	R-1498
R563	A6	R-1596
R564	A7	R-0976
R565	A2	R-0821
R566	A3	R-0821
R567	A4	R-0821
R568	A7	R-0821
R569	A2	R-0777
R570	A5	R-0777
R571	A3	R-0777
R572	A4	R-0777
R573	A1	R-0777
R574	A1	R-0807
R575	B5	R-0728
R576	B5	R-0824
R577	C5	R-0742
R578	C4	R-0742
R579	C4	R-0821

F

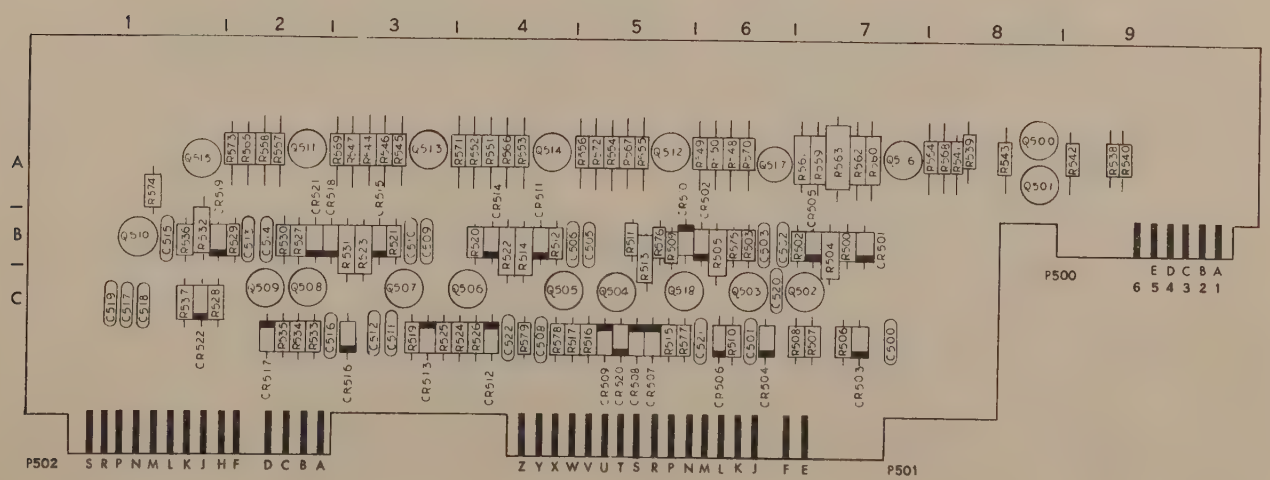


Figure 10-9 2.5 Mc Standard Decade Parts Location Detail, Assy. 13269

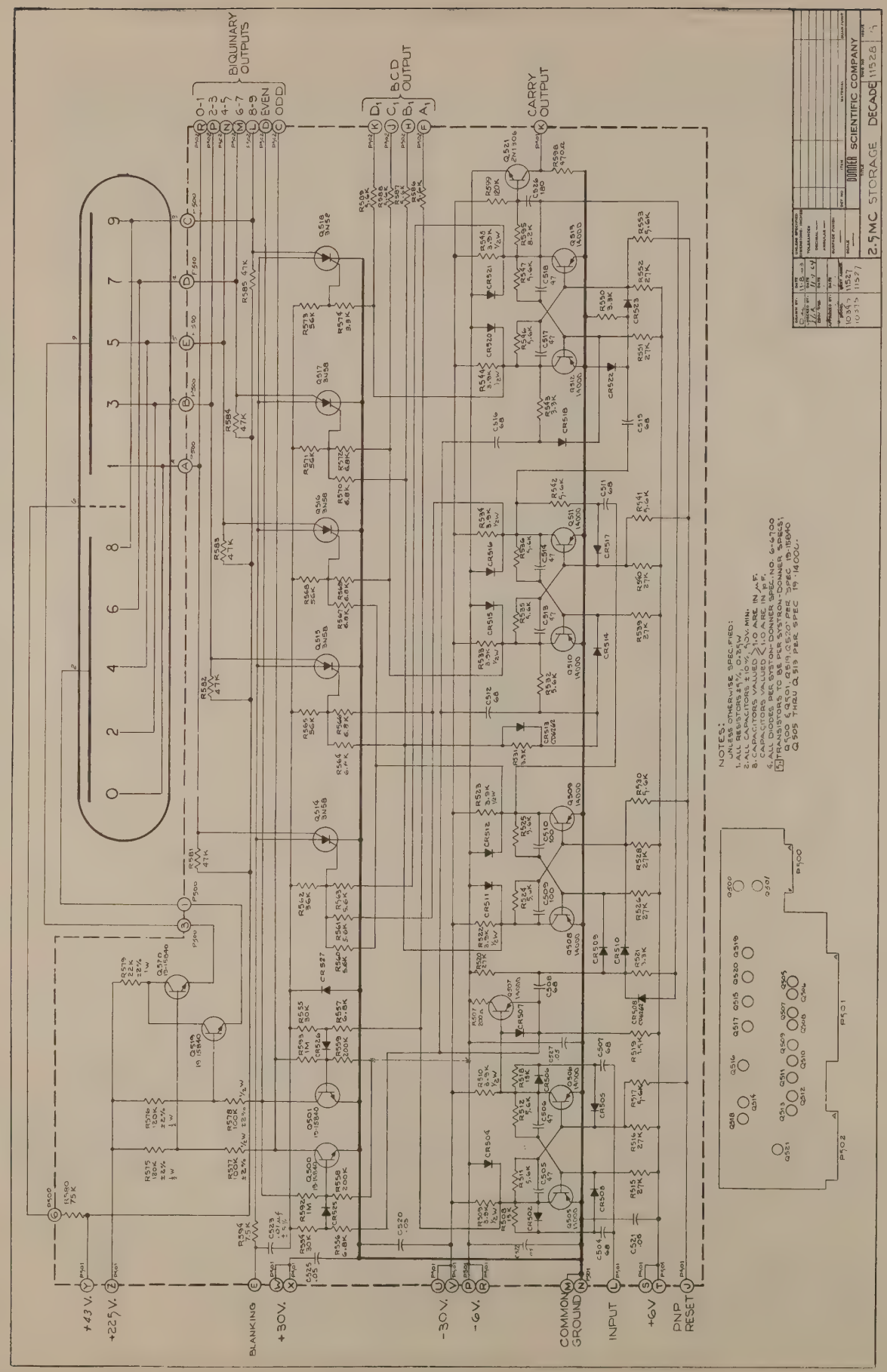


Figure 10-10 2.5 Mc Storage Decade Schematic No. 11528

Schem. Ref.	Illus. Index	S-D Part
CAPACITORS		
C504	C6	C-0635
C505	B5	C-0533
C506	B5	C-0533
C507	C5	C-0635
C508	C5	C-0635
C509	B4	C-0536
C510	B4	C-0536
C511	C4	C-0635
C512	C3	C-0635
C513	B3	C-0533
C514	B3	C-0533
C515	C3	C-0635
C516	C3	C-0635
C517	B2	C-0533
C518	B2	C-0533
C520	C1	C-0708
C521	C2	C-0708
C522	C1	C-0708
C523	C6	C-0705
C525	C1	C-0708
C526	B1	C-0643
C527	C5	C-0708
DIODES		
CR502	B6	6700
CR503	C6	6700
CR504	B6	6700
CR505	C5	6700
CR506	B5	6700
CR507	C5	6700
CR508	C4	CR-0150
CR509	C4	6700
CR510	C4	6700
CR511	B5	6700
CR512	B4	6700
CR513	C4	-0150
CR514	C3	6700
CR515	B3	6700
CR516	B3	6700
CR517	C3	6700
CR518	C2	6700
CR520	B2	6700
CR521	B1	6700
CR522	C1	6700
CR523	C2	6700
CR525	A8	6700
CR526	A7	6700
CR527	A1	6700

Schem. Ref.	Illus. Index	S-D Part
TRANSISTORS		
Q500	A7	15840
Q501	A7	15840
Q505	C6	14000
Q506	C5	14000
Q507	C5	14000
Q508	C4	14000
Q509	C4	14000
Q510	C3	14000
Q511	C3	14000
Q512	C2	14000
Q513	C2	14000
Q514	A2	Q-0136
Q515	A5	Q-0136
Q516	A3	Q-0136
Q517	A4	Q-0136
Q518	A1	Q-0136
Q519	A6	15840
Q520	A5	5840
Q521	B1	Q-0075
RESISTORS		
R507	B5	R-0736
R508	B6	R-0728
R509	B6	R-0616
R510	B5	R-0616
R511	B6	R-0821
R512	B5	R-0821
R515	C6	R-0824
R516	C6	R-0824
R517	C6	R-0821
R518	B5	R-0728
R519	C5	R-0783
R520	B5	R-0824
R521	C5	R-0742
R522	B5	R-0616
R523	B4	R-0616
R524	B4	R-0821
R525	B4	R-0821
R526	C4	R-0824
R528	C5	R-0824
R530	C4	R-0821
R531	C4	R-0742
R532	C4	R-0821
R533	B4	R-0616
R534	B2	R-0616
R535	B3	R-0821
R536	B3	R-0821
R539	C3	R-0824
R540	C3	R-0824
R541	C3	R-0821
R542	C3	R-0821
R543	B2	R-0742
R544	B2	R-0616
R545	B1	R-0616
R546	B2	R-0821
R547	B2	R-0821

Schem. Ref.	Illus. Index	S-D Part
RESISTORS		
R550	C1	R-0742
R551	C2	R-0824
R552	C2	R-0824
R553	C2	R-0821
R554	A8	R-0715
R555	A7	R-0715
R556	A8	R-0696
R557	A7	R-0696
R558	A8	R-0823
R559	A7	R-0823
R560	A3	R-0821
R561	A3	R-0821
R562	A2	R-0705
R563	A2	R-0821
R564	A5	R-0696
R565	A5	R-1235
R566	A5	R-0696
R567	A3	R-0696
R568	A3	R-1235
R569	A4	R-0696
R570	A4	R-0696
R571	A4	R-1235
R572	A4	R-0696
R573	A2	R-1235
R574	A2	R-0742
R575	A6	R-1499
R576	A6	R-1499
R577	A6	R-1498
R578	A6	R-1498
R579	A6	R-1596
R580	A7	R-0580
R581	A2	R-0777
R582	A5	R-0777
R583	A3	R-0777
R584	A4	R-0777
R585	A1	R-0777
R586	A7	R-0821
R587	A4	R-0821
R588	A3	R-0821
R589	A2	R-0821
R592	A8	R-0962
R593	A7	R-0962
R594	A8	R-0884
R595	B1	R-0993
R598	C1	R-1044

MISCELLANEOUS	
P.C.Board	11529
P.C.Board Stiffener, Silk Screen Assy.	15373
P.C.Board Stiffener	1-9669
Nylon Bushing	H-0941
Transistor Pad	H-0515

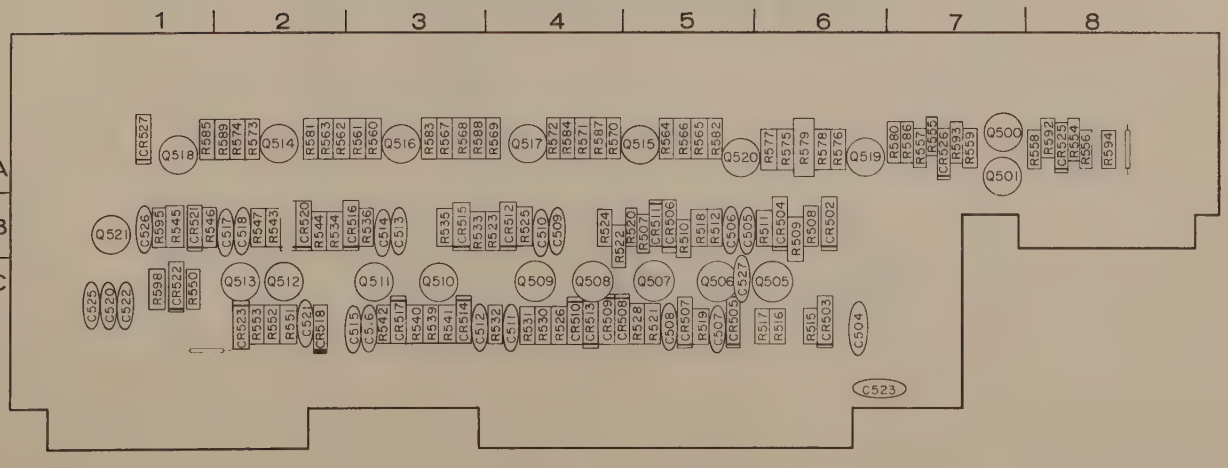


Figure 10-11 2.5 Mc Storage Decade Parts Location Detail No. 11527

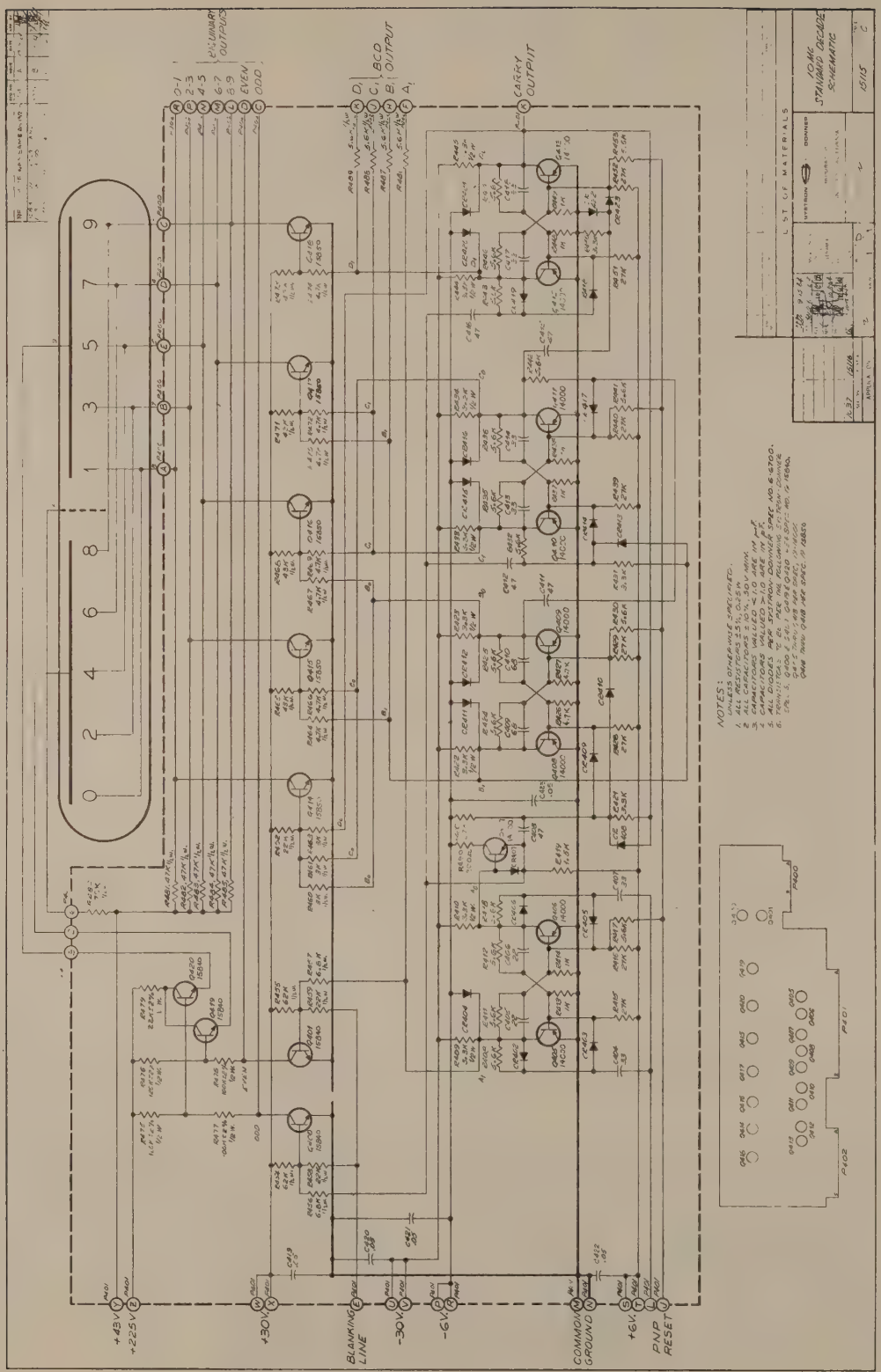


Figure 10-12 10 Mc Standard Decade Schematic No. 15115

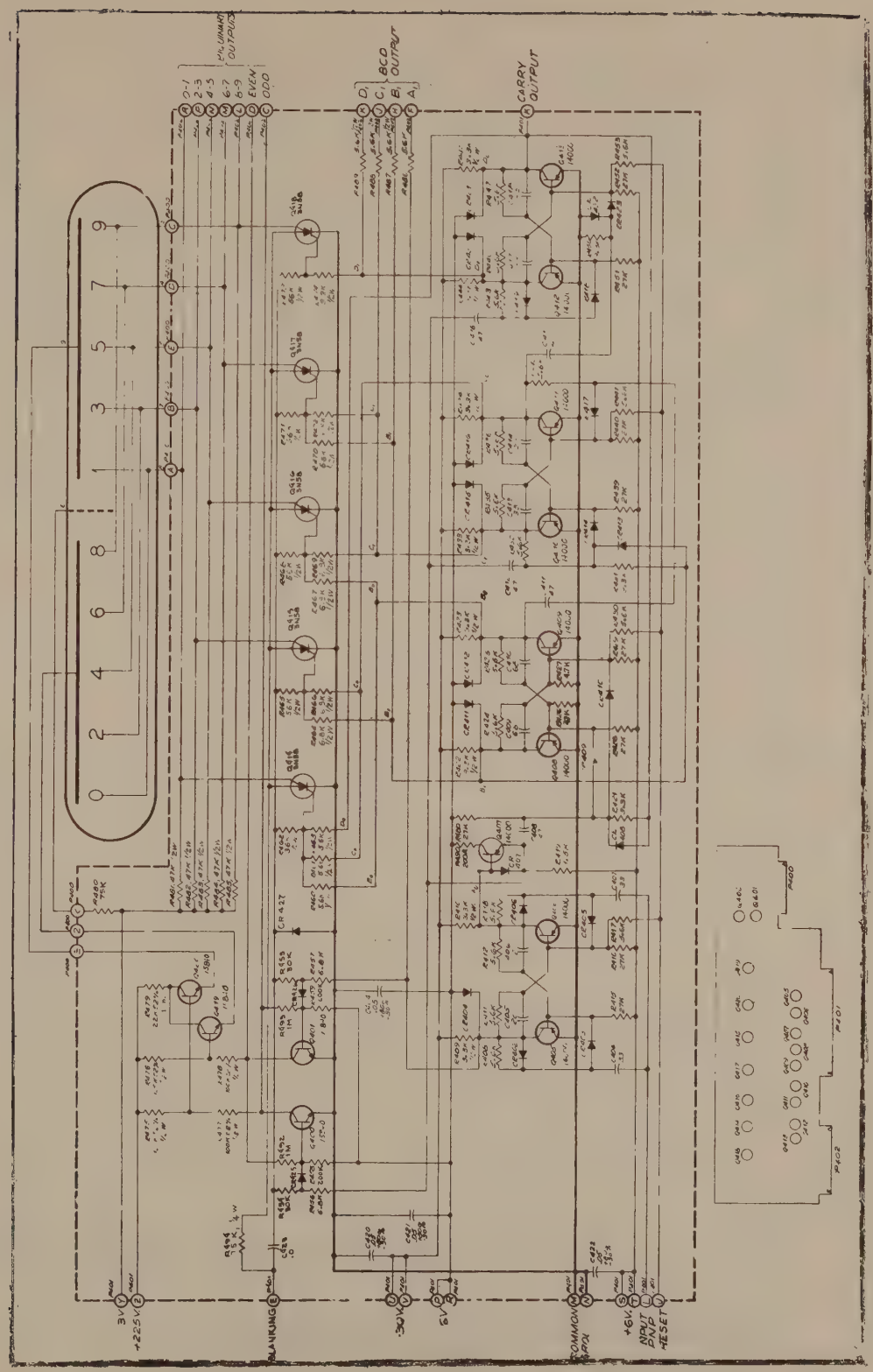


Figure 10-13 10 Mc Storage Decade Schematic No. 15201

Table 10-7 10 Mc Decade Composite Parts List

(Refer to Master Parts List for Part Description)

Schem. Ref.	Illus. Index	S-D Part*
CAPACITORS		
C404	C6	C-0531
C405	B5	C-0529
C406	B5	C-0529
C407	C5	C-0531
C408	C5	C-0533
C409	B4	C-0635
C410	B4	C-0635
C411	C3	C-0533
C412	C3	C-0533
C413	B2	C-0531
C414	B2	C-0531
C415	C2	C-0533
C416	C2	C-0533
C417	B1	C-0531
C418	B1	C-0531
C419 N	C1	C-0708
C420	C1	C-0708
C421	C1	C-0708
C422	C2	C-0708
C423	C5	C-0708 N / C-0705 S
C424 S	C6	N/A / C-0708
DIODES		
CR402	B6	6700
CR403	C6	6700
CR404	B6	6700
CR405	C5	6700
CR406	B5	6700
CR407	C5	6700
CR408	C4	6700
CR409	C4	6700
CR410	C4	6700
CR411	B4	6700
CR412	B3	6700
CR413	C4	6700
CR414	C3	6700
CR415	B3	6700
CR416	B2	6700
CR417	C2	6700
CR418	C2	6700
CR419	B1	6700
CR420	B2	6700
CR421	B1	6700
CR422	C1	6700
CR423	C1	6700
CR425 S	A7	6700 S
CR426 S	A7	6700 S
CR427 S	A1	6700 S
MISCELLANEOUS		
11529		P.C. Board
15371		P.C. Board Stiffener Silk Screen Assy
9669		P.C. Board Stiffener
H-0941		Nylon Rivets, #38-104-06-13

Schem. Ref.	Illus. Index	S-D Parts*
TRANSISTORS		
Q400 S	A7	15840
Q401 S	A7	15840
Q405	C6	1400 / 15840
Q406	C5	1400 / 15840
Q407	C4	1400 / 15840
Q408	C4	1400 / 15840
Q409	C3	1400 / 15840
Q410	C3	1400 / 15840
Q411	C2	1400 / 15840
Q412	C1	1400 N / 15840 S
Q413	C1	1400 / 15840
Q414	A1	15850 / 0136
Q415	A4	15850 / 0136
Q416	A2	15850 / 0136
Q417	A3	15850 / 0136
Q418	A1	15850 / 0136
Q419	A6	15850 / 15840
Q420	A5	15850 / 15840
RESISTORS		
R408	B6	R-0821
R409	B6	R-0136
R410	B5	R-0136
R411	B6	R-0821
R412	B5	R-0821
R413N	C6	R-0765 N
R414N	C6	R-0765 N
R415	C6	R-0824
R416	C6	R-0824
R417	C6	R-0821
R418	B5	R-0821
R419	C5	R-0783
R420	B4	R-0824
R421	C4	R-0742
R422	C4	R-0136
R423	B3	R-0136
R424	B4	R-0821
R425	B3	R-0821
R426	B4	R-0892
R427	B4	R-0892
R428	C4	R-0824
R429	C4	R-0824
R430	C4	R-0821
R431	C3	R-0742
R432	C3	R-0821
R433	B3	R-0136
R434	B2	R-0136

Schem. Ref.	Illus. Index	S-D Part*
RESISTORS		
R435	B3	R-0821
R436	B2	R-0821
R437 N	B2	R-0765 N
R438 N	B3	R-0765 N
R439	C3	R-0824
R440	C3	R-0824
R441	C3	R-0821
R442	C2	R-0821
R443	B1	R-0821
R444	B2	R-0136
R445	B1	R-0136
R446	B1	R-0821
R447	B1	R-0821
R448 N	C2	R-0765 N
R449 N	C1	R-0765 N
R450	C1	R-0742
R451	C1	R-0824
R452	C1	R-0824
R453	C1	R-0821
R454	A7	R-0576 N / R-0715 S
R455	A7	R-0576 N / R-0715 S
R456	A7	R-0514
R457	A7	R-0514
R458	A7	R-0527 / R-0823
R459	A7	R-0527 / R-0823
R460	A2	R-1701 / R-0562
R461	A2	R-1701 / R-0562
R462	A2	R-0527 / R-0585
R463	A2	R-1701 / R-0562
R464	A5	R-0522 / R-0514
R465	A5	R-0230 N / R-0137 S
R466	A5	R-0522 / R-0514
R467	A3	R-0522 / R-0514
R468	A3	R-0230 / R-0137
R469	A3	R-0522 / R-0514
R470	A4	R-0522 / R-0514
R471	A4	R-0230 / R-0137
R472	A4	R-0522 / R-0514
R473	A1	R-0230 / R-0137
R474	A1	R-0522 / R-0136
R475	A6	R-0736
R476	A6	R-1499
R477	A6	R-1499
R478	A6	R-1498
R479	A6	R-1498
R480	A7	R-1596
R481	A2	R-0252
R482	A5	R-0144
R483	A3	R-0144
R484	A4	R-0144
R485	A1	R-0144
R486	A7	R-0562
R487	A4	R-0562
R488	A3	R-0562
R489	A1	R-0562
R490	B4	R-0562
R492	A7	R-0962 / R-0562
R493	A7	R-0962 N / R-0562 S
R494	A7	R-0884 / R-0562

*Applicable to:
Standard Board No. 15115
S Option Board No. 15200

NOTES:
1—Components not marked N or S are on all boards regardless of option:
2—Components marked N are on non-storage option boards only:
3—Components marked S are on storage option boards only:
4—Refer to Master Parts List (Section 13) for component description:

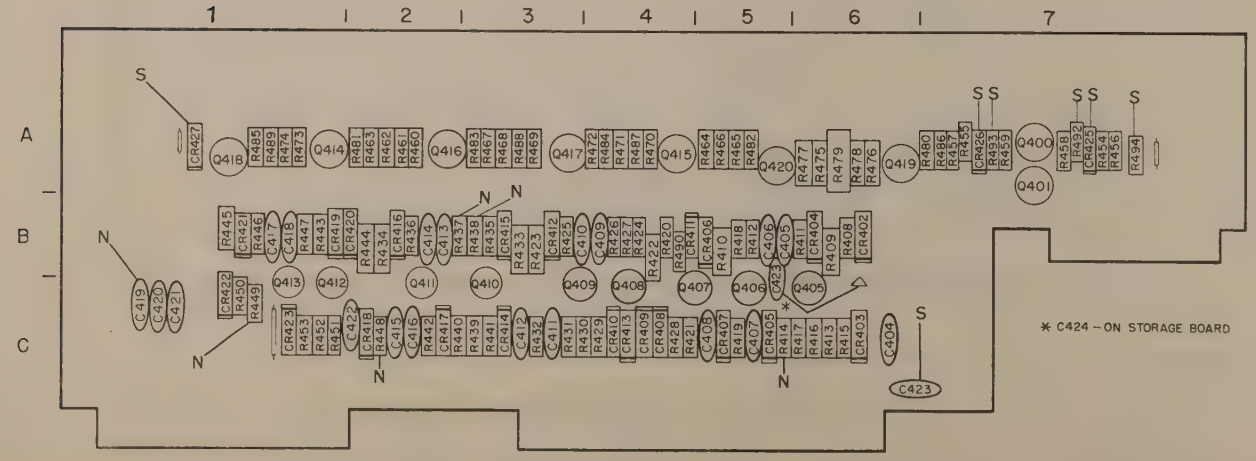


Figure 10-14 10 Mc Composite Parts Location Detail, Std. No. 15116, Storage No. 15

SECTION 11 — POWER SUPPLY

11-1 CIRCUIT DESCRIPTION

11-2 Voltage Sources. The following paragraphs and Table 11-1 cite the method of development and uses of the voltages developed in the counter power supply.

Table 11-1 Power Supply Output Voltages

Voltage	Current	Use
+30V	500ma	Transistor biasing
-30V	500ma	Transistor biasing
+ 6V	500ma	Transistor biasing
- 6V	500ma	Transistor biasing
+225	50ma	Indicator tube B+
+43V	5ma	Indicator tube biasing
+20V	10ma	Heterodyne unit
-15V	50ma	Heterodyne unit

11 3 The +30V, -30V, +6V and -6V outputs are obtained from individual voltage regular sections, a common regulator section. Using the -30V section as an illustration, a full-wave diode rectifier (CR11 and CR12) generates an unregulated 40 volts which is applied to an "L" filter consisting of R5 and C5. The filtered DC passes through a series regulator (Q5), a type 2N2138 transistor, to the output terminal. The regulator is controlled by degenerative feedback from the regulating amplifier, Q106 and Q107, and acts as a variable impedance device which compensates for changes in output voltage level. At a stable condition, the voltage at the arm of R131 in the output divider network is virtually zero with respect to the fixed bias level at the emitter of Q106 created by Zener diode CR105, which is the prime reference for the supply. When the output level drifts, an error voltage at the arm of R131 is sensed by the regulating amplifier. The degenerative loop action of the amplifier tends to reduce the error voltage to zero again. The output voltage level can be varied by changing the setting of R131. Output regulation is maintained to within 2%.

11-4 The +30V power supply is identical except that the circuit is grounded at the low side, which shifts the high side to a +30V level.

11-5 In the +6V and -6V supplies, Q3 and Q4 are the series regulators and Q104 and Q105 are the corresponding amplifiers. Regulation is dependent, not upon +6V and -6V outputs but upon the +30V and -30V outputs applied to the amplifiers through R115 and R121 respectively. The fixed-bias reference for each of these amplifiers is provided by the voltage across Zener diodes CR103 and CR104.

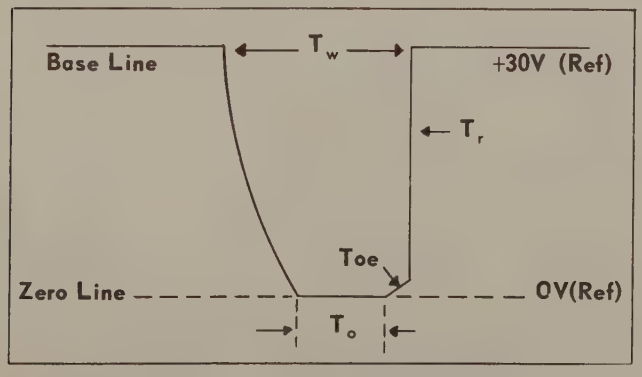


Figure 11-1 Storage Output Waveform

11 6 The +225V output is generated by a bridge type rectifier circuit (CR1 through CR4) having a low power-type 2N375 series regulator transistor, Q1 which is controlled by a single-stage-amplifier, Q101. The -30V regulated output applied to R103 in the divider network is the prime reference for this circuit.

11-7 The +43V output is generated by a type IN716 13-volt Zener diode, CR101, connected across the 30V and 225V outputs.

11-8 Blanking Circuit. The indicator tubes may, at the operator's wish, be blanked-out during the count cycle so that an indication is obtained only after the final count is registered. Blanking is accomplished when Q109 is turned off and a +15V is applied to the blanking line to each decade unit. This positive voltage turns on both transistors in the binary section of the bi-quinary drive circuit (Q400, Q401, Q500, Q501, etc.) which turn off the following switch transistors, removing B+ from the indicator tubes. The blanking gate consists of inputs through diode CR106 and resistors R133 and R134. When any of these inputs is connected to -6V or greater, transistor Q108 will turn off and transistor Q109 will turn on to prevent blanking. Thus, if the blanking switch is in the "off" position, or the Function switch is in the Count or Hold mode, no blanking will occur. With blanking on, the end-of-count signal input from the Display and Reset module will control blanking. At reset and during the count cycle, this input is 0 volts and and blanking takes place, since Q108 is on. After the "stop" pulse, a -6V end-of-count signal level occurs which removes blanking.

11-9 Storage The optional circuitry for the storage function produces an output waveform, illustrated in Figure 9.1, which controls the Silicon-Controlled Switch used in the storage decades provided with Option S. The negative end-of-count pulse is applied to one-shot circuit consisting of Q111 and Q112. The resulting waveform is applied as one input to an AND gate together with the normal quinary gating signals described in section 8, "Bi-Quinary Drive Circuit." The negative portion of the waveform turns the SCS off and blanks the indicator. One millisecond later, when the following positive pulse is received, the SCS will turn on if the proper quinary gating signals are present. Once the SCS is turned on, its holding characteristics will keep it turned on, regardless of how the quinary gating signals may change. The indicator, therefore, will hold the count which has occurred at the end-of-count signal and will not indicate subsequent counts until the following end-of-count pulse turns it off and then on again.

11-10 When the storage function is switched off by the Blanking/Storage switch or the Function selector in the "Count-Hold" function, a -30V is applied through CR108 or CR109 which releases the unijunction relaxation oscillator (Q113). This circuit is identical to the automatic reset oscillator in the Display and Reset circuitry except that it oscillates at approximately 100 cps. The squarewave output triggers the storage one-shot at this rate, in place of the end-of-count signal, thereby effectively defeating the storage function.

11-11 TROUBLESHOOTING

11-12 When operation indicates a possible malfunction refer to Table 11-2 and preform voltage and resistance checks as required to determine the defective component. Schematics and parts location details are provided at the end of this section.

Table 11-2 Power Supply Trouble Symptom Guide

(Component Schematic Reference numbers apply to -30V section only.)

Symptom	Cause
Voltage not regulated, may oscillate slowly.	Zener reference diode CR105, open
Voltage varies with line voltage or load change.	Loss of gain in regulator transistors, Q106 or Q102.
Excessive ripple, high output.	Defective Zener diode, CR105. Filter capacitor open, C5.
Excessive ripple, low output.	Diode rectifier, CR11 or CR12 open.
Output cannot be adjusted.	Regulator transistor open Q106, Q107.
No output, one section.	Fuse or series control transistor 2N2138 open. Transformer secondary winding open (Check unregulated d.c. or a.c.)
No output, all sections.	Transformer primary open
Blanking Circuitry	
No illumination with blanking on (normal with blanking off)	Q108 leaky, Q109 open, CR106 open
No blanking	Q108 and Q109 shorted

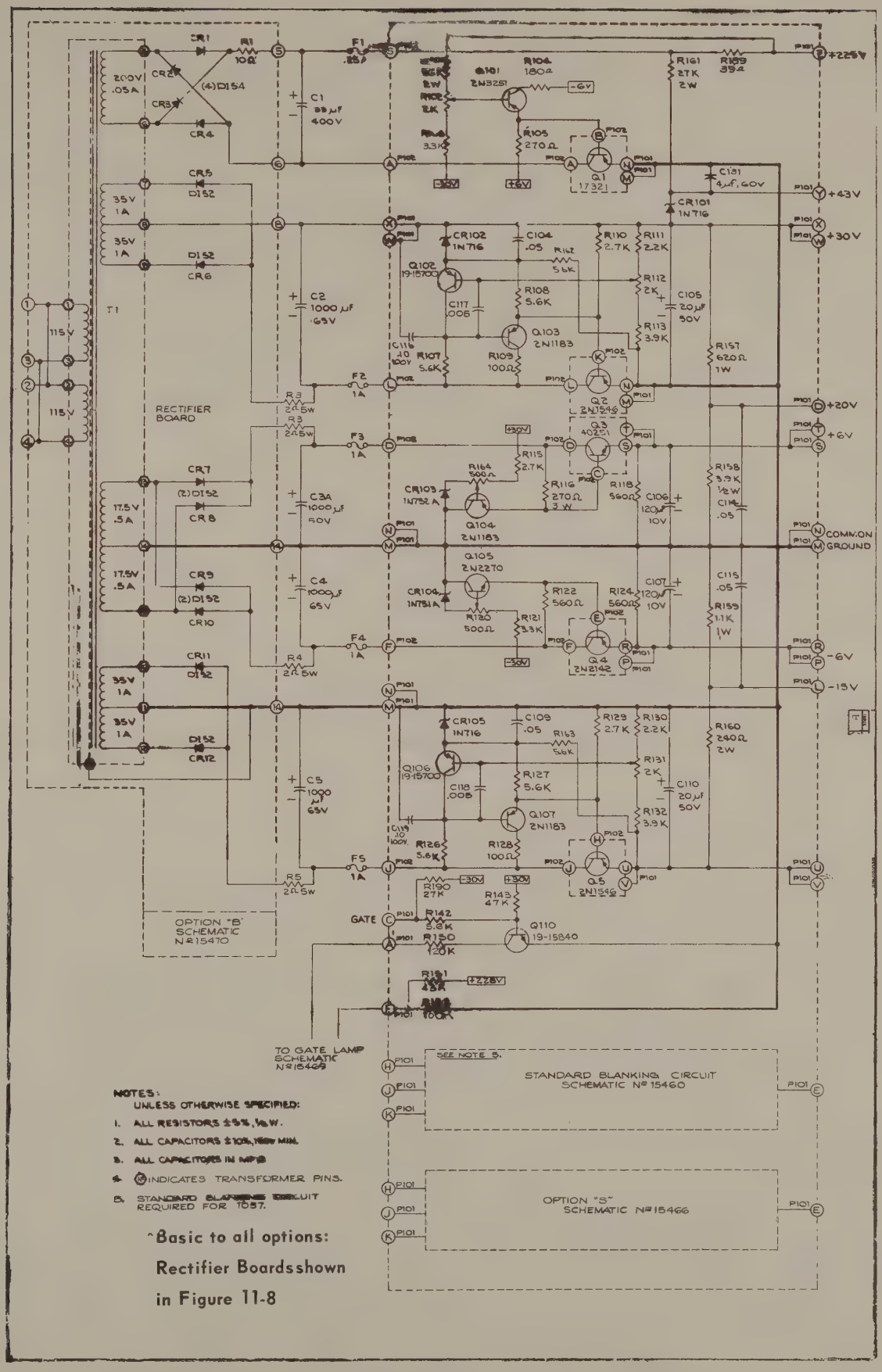
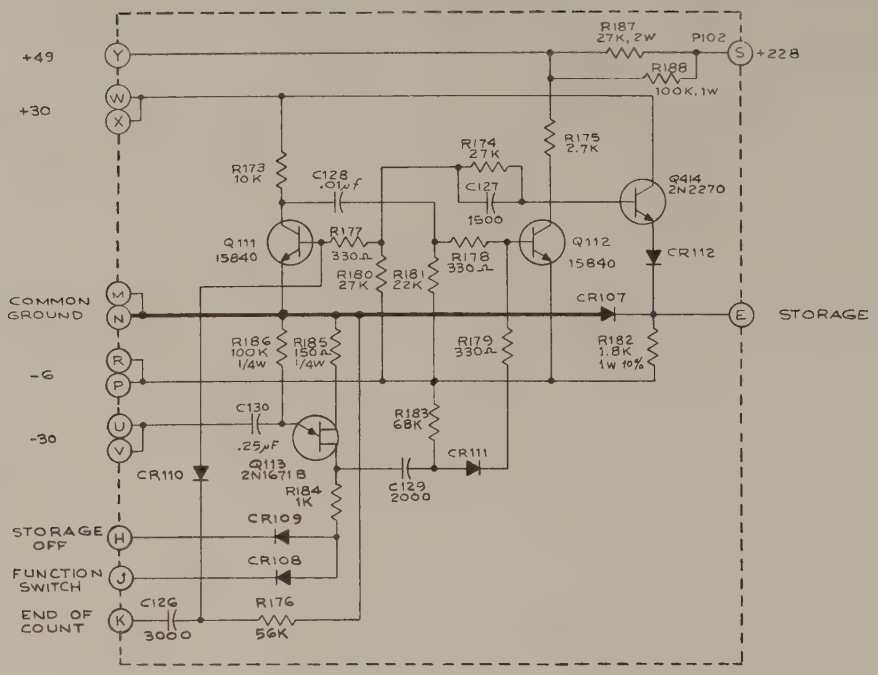
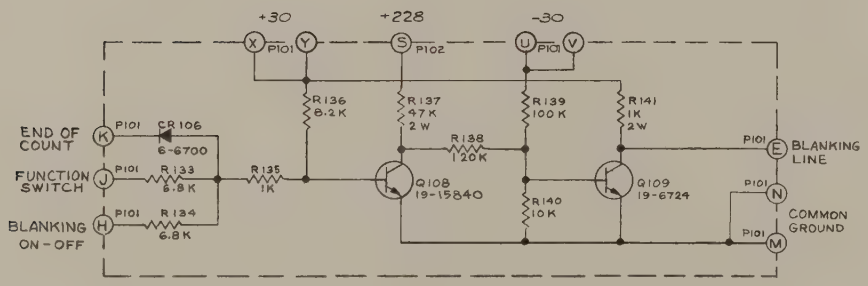


Figure 11-2 Basic Power Supply Schematic No. 15413



NOTES:
UNLESS OTHERWISE SPECIFIED:
1. ALL RESISTORS 1/2W, 5%, COMP. CARB.
2. ALL CAPACITANCE IN PICOFARADS.
3. ALL DIODES G700.
4. ALL PINS ARE P101 OF PWR. SUPPLY P.C. BD. (SCHEMATIC Nº 15413).

Figure 11-3 Standard Blanking Circuit Schematic No. 15460 ***Use with Dwg. 15413**



NOTES:
UNLESS OTHERWISE SPECIFIED:
1. ALL RESISTORS ±5%, ½W.
2. (K) - INDICATES PIN Nº'S ON POWER SUPPLY P.C. BOARD (SCHEMATIC Nº 15413)

Figure 11-4 Option "S" Schematic No. 15466

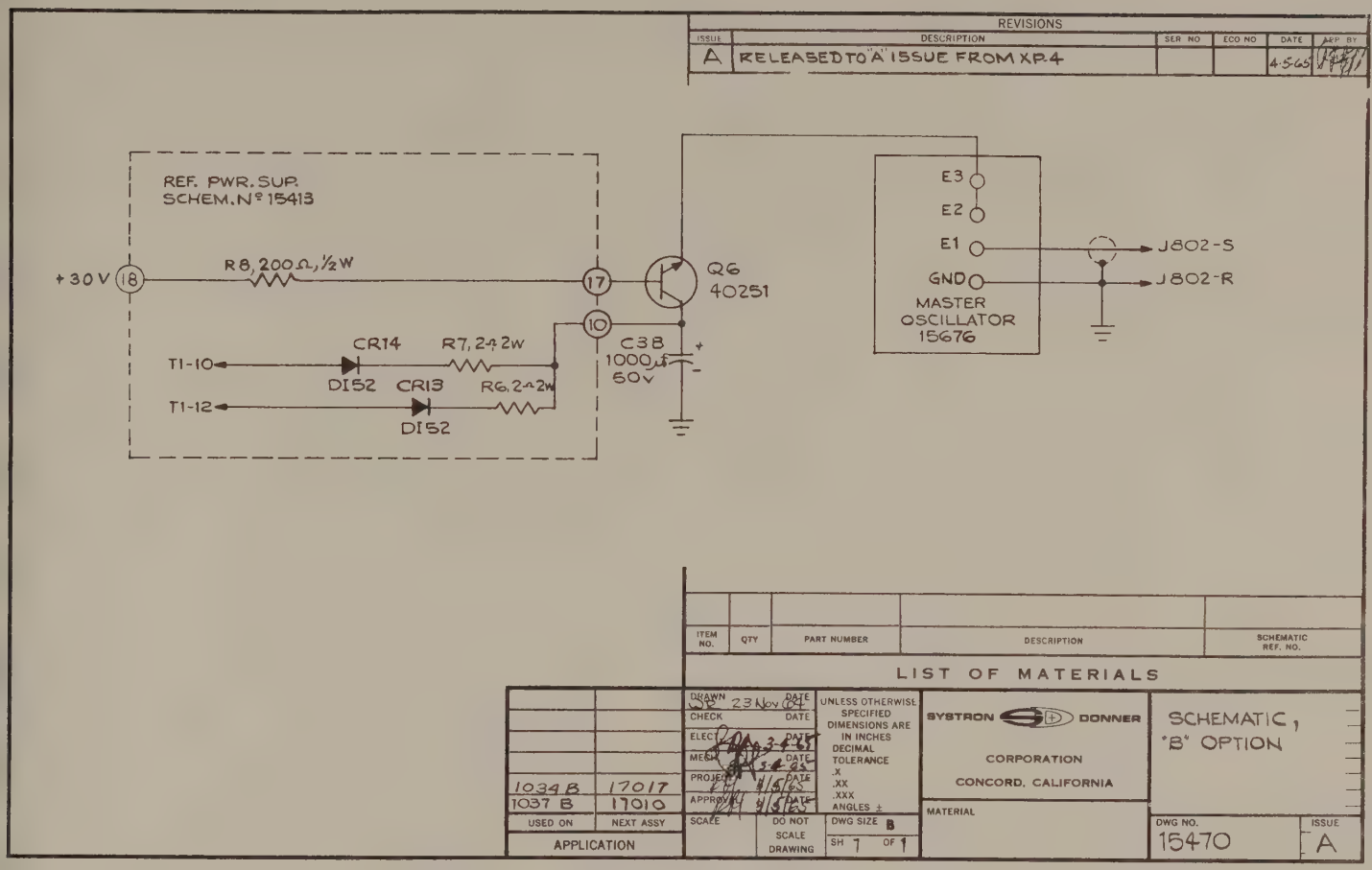


*Figure 11-5 * Option B Schematic No. 15470* *Use with Dwg. 15413

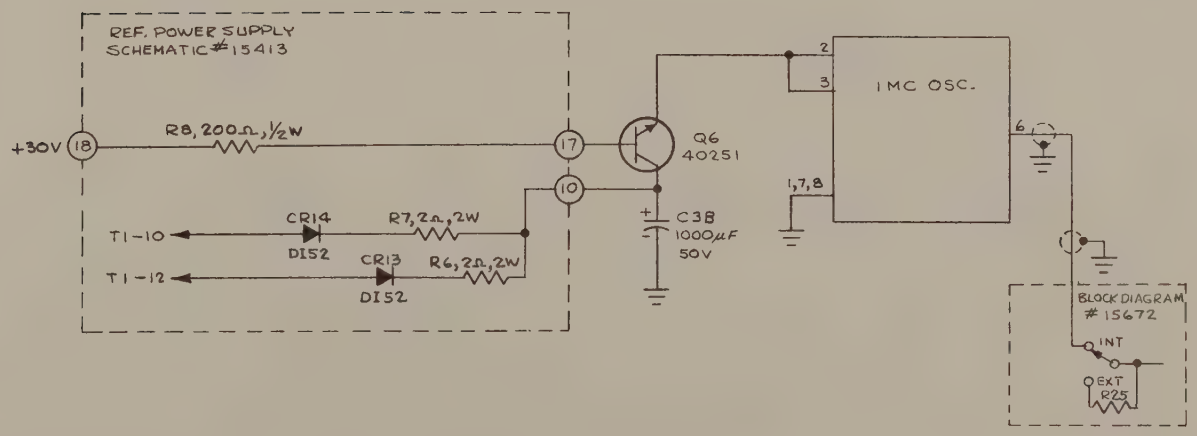


*Figure 11-6 * Option B Schematic No. 15847*

Table 11-3 Power Supply Composite Parts List

Schem Ref.	Illus Index	S-D Part
CAPACITORS		
C101	B3	C-0542
C104	B1	C-0708
C105	B4	C-0664
C106	B5	C-0732
C107	A5	C-0732[S] C0228[N]
C109	B2	C-0708
C110	B4	C-0664
C114	B4	C-0708
C115	B4	C-0708
C116	C1	C-0564
C117	B1	C-0325
C118	B1	C-0325
C119	C2	C-0564
C126	A6	C-0759[S]
C127	A6	C-0760[S]
C128	A6	C-0441[S]
C129	B4	C-0544
C130	B5	C-0632
C131	C3	C-0417
DIODES		
CR101	C4	CR-0132
CR102	B1	CR-0132
CR103	B3	CR-0064
CR104	B3	CR-0095
CR105	B2	CR-0132
CR106	C4	6-6700[N]
CR107	C5	6-6700
CR108	C4	6-6700
CR109	C4	6-6700
CR110	B6	6-6700 [S]
CR111	B6	6-6700
CR112	C5	6-6700
CR113	B3	CR-0228
TRANSISTORS		
Q101	B3	Q-0157
Q102	B1	19-15700
Q103	B1	Q-0080
Q104	B3	Q-0080
Q105	B3	Q-0102
Q106	B2	19-15700
Q107	B2	Q-0080
Q108[N]	B5	15840[N]
Q109[N]	C5	6724 [N]
Q110	C5	19-15840
Q111	B6	19-15840
Q112	B6	19-15840 [S]
Q113	B5	Q-0084
Q114	B6	Q-0102

Schem Ref.	Illus Index	S-D Part
RESISTORS		
R101	C3	1589
R102	A3	1297
R103	A3	0136
R104	B4	0725
R105	A4	0365
R107	A1	0562
R108	A1	0562
R109	A1	0466
R110	A1	0143
R111	A1	0259
R112	A1	1287
R113	A1	0616
R115	A4	0143
R116	A3	1863
R118	A5	1083
R120	A3	1317
R121	A3	0136
R122	A3	1083
R124	A5	1083
R126	A2	0562
R127	A2	0562
R128	A2	0466
R129	A2	0143
R130	A2	0259
R131	A2	1287
R132	A2	0616
R133	C5	0514
R134	C5	0514
R135	C5	0278
R136	B5	0472
R137	B6	1116[N]
R138	A6	0293
R139	A6	0352
R140	A6	0292

Schem Ref.	Illus Index	S-D Part
R141[N]	C6	1573
R142	C5	0562
R143	C5	0144
R150	C5	0293
R151	C5	0230
R152	C5	0355
R157	C4	1590
R158	C4	0616
R159	C4	1669
R160	C3	1295
R161	C3	0619
R162	C1	0562
R163	C2	0562
R164	A3	1317
R173	A6	0292
R174	A6	0564
R175	A6	0143
R176	A6	0137
R177	A6	1315
R178	A6	0315
R179	A6	0315
R180	A6	1564
R181	A6	1527[S]
R182	C5	0643
R183	A6	0273
R184	C4	0278
R185	B5	0983
R186	B5	0741
R187	C3	0619
R188	C3	0356
R189	C1	0724
R190	B5	0564

MISCELLANEOUS

Schem Ref.	S-D Part	
P.C. Bd. P.S. Ass'y	2-12970[S]	15412[N]
P.C. Bd. P.S.	29-15411	
P.C. Bd. [illegible]ier		
Silk Screen assy	2-15329[S]	15424[N]
P.C. Bd. Stiffener	1-9669	

NOTES:*
1–Components not marked N or S are on all boards regardless of option:
2–Components marked N are on non-storage option boards only:
3–Components marked S are on storage option boards only:
4–Rectifier board components are shown in Figure 11-8:
5–Refer to Master Parts List (Section 13) for component descriptions

***Use with Dwg. 15413**

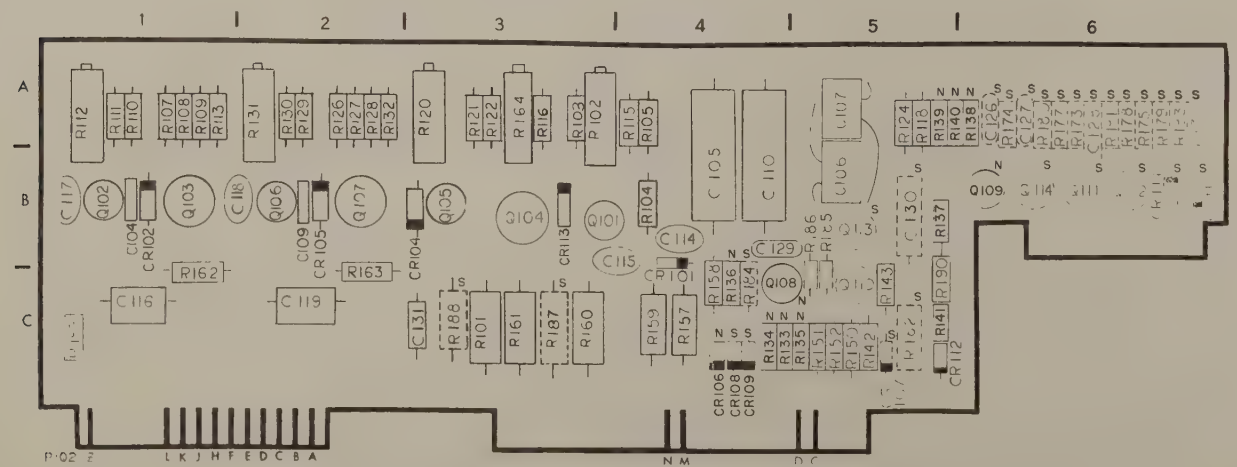
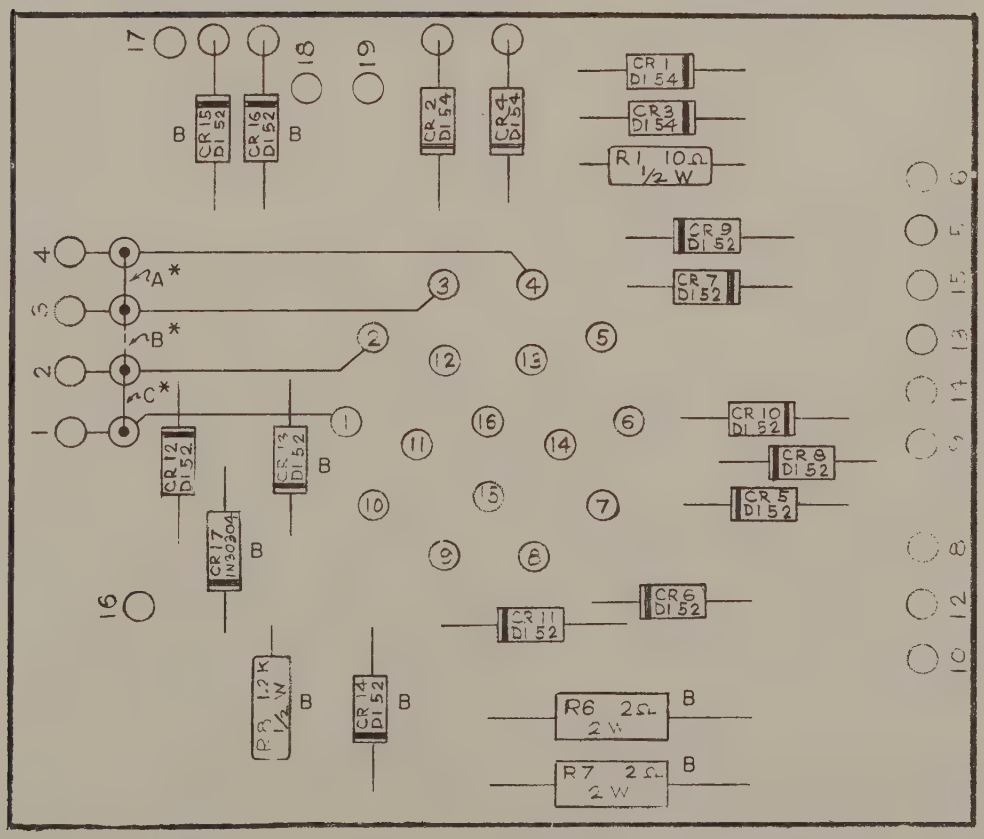


Table 11-4 Rectifier Board Composite Parts List

CAPACITORS		DIODES		TRANSISTORS		TRANSFORMER	RESISTORS
Schem. Ref	S-D Part No.	S-D Part No.	Schem Ref.	Schem. Ref	S-D Part No.	T1 1-13516 A/W 15047 9-1532b	Schem Ref.
C1	5-13491	CR5	CR-0148	Q1	Q-0171		R1
C2	5-13490	CR6	CR-0148	Q2	Q-0170	P. C. BD. RECTIFIER ASSY.	R2
C3	C-0800	CR7	CR-0148	Q3	Q-0166		R3
C4	5-13490	CR8	CR-0148	Q4	Q-0104	2-15414	R4
C5	5-13490	CR9	CR-0148	Q5	Q-0170		R5
		CR10	CR-0148	Q6	Q-0166		R6**
DIODES		CR11	CR-0148			P. C. BD. RECTIFIER	R7**
Schem. Ref.	S-D Part No.	CR12	CR-0148	FUSES			R8**
CR1	CR-0149	CR13	CR-0148			A/W 15399 29-15400	R19
CR2	CR-0149	CR14**	CR-0148	F1	F-0043		R20
CR3	CR-0149	CR15**	CR-0148	F2	F-0001		R21
CR4	CR-0149	CR16**	CR-0148	F3	F-0001		R22
		CR17	CR-0224	F4	F-0001		R23
				F5	F-0001		R24

**Components marked B and B3 are on B and B3 option boards only.



* Remove jumpers A and C and install jumper B for 230V conversion (See paragraph 2-9)

Figure 11-8 Rectifier Board Parts Location Detail, No. 15401

12 — MAINTENANCE INSTRUCTIONS

12-1 GENERAL

12-2 This section contain servicing and testing instructions for the Model 1037 counters and the 1926A amplifier plug-in. For other plug-in models, refer to the corresponding manuals. These instructions are applicable to all options unless otherwise indicated.

12-3 LIST OF TEST EQUIPMENT

12-4 Recommended test equipment for trouble shooting and performance checking is listed in Table 12-1. Test instruments other than those listed may be used if their specifications equal or exceed the required characteristics.

Table 12-1 Test Equipment Requirements

INSTRUMENT TYPE	REQUIRED CHARACTERISTICS	INSTRUMENT RECOMMENDED
Oscilloscope	50 Mc bandwidth, dual trace plug-in extention sync. capability	Tektronix Model 581 with Type 82 plug-in unit
Low Frequency Generator	Continuously variable from 10 cps to 1 kc, 100 Mv output	Hewlett Packard Model 202A
Test Oscillator	Continuously variable from 5 kc to 50 Mc, 100Mv output	General Radio Model 1330A
Volt-ohm Meter	0V – 250V 3% Accuracy	Simpson Type 262
Variable Line Voltage Source	Variable from 100 to 130V AC	Superior UCIM
Squarewave Generator	0 – 10Mc, 10V output	Tektronix Type 107
Frequency Standard	1 Mc, one part in 10^{10} stability	Rhodes and Schwartz
Plug-in Amplifier	Dual channel input amplifier	Systron-Donner Model 1926A
Jumper Plug-in	For J-1 (or blank plug-in)	

12-5 TROUBLE SHOOTING AND REPAIR

12-6 Preliminary. Remove the top and bottom covers to gain access to all test points and adjustments

WARNING

115/220V AC and DC supply wires are exposed when either the top or bottom cover is removed. Exercise caution during trouble-shooting, adjustment or repair.

12-7 General Procedure

12-8 When malfunction is suspected, disconnect all equipment from the counter and perform the self-check procedure given in paragraph 12-20 If the counter checks properly, check that all inputs are within limits of the specifications. The input signal may be intermittent or have a small signal-to-noise ratio. Damaged connecting cables may be causing noise or intermittent connections. If the counter does not self-check properly, refer to the trouble-shooting guides given in the circuit theory sections for the individual modules (sections 4 through 10)) and also perform the test procedure starting with paragraph 12-12, or as much of it as necessary.

12-9 Substitution. Trouble-shooting may be greatly simiplified if checking is done by a replacing assembly suspected of malfunction with a spare assembly known to be operating correctly. When the malfunctioning assembly is found, the trouble then may be traced to individual components responsible for malfunction, or the assembly may be shipped to your Systron-Donner Representative for repair.

12-10 Printed Circuit Component Replacement.

12-11 Component lead holes in the Model 1037 circuit boards have plated walls to insure good electrical contact between conductors on the opposite sides of the board. To prevent damage to this plating and to the replacement component, apply heat sparingly and work carefully. The following replacement procedure is recommended.

a. Remove defective component.

b. Melt solder in component lead holes. Use clean dry soldering iron to remove excess solder. Clean holes with tooth pick or wooden splinter. Do not use metal tool for cleaning as this may damage through-hole plating.

c. Bend leads of the replacement component to the correct shape and insert component leads into component lead holes. Using heat and solder sparingly, solder leads in place. Heat may be applied to either side of board. A heat sink (longnose pliers, commercial heat-sink tweezers, etc.) should be used when replacing transistors and diodes in order to prevent conduction of excessive heat from the soldering iron to the component.

d. Through-hole plating breaks are indicated by the separation from the board of the round conductor pad on either side of the board. To repair breaks, press conductor pads against board and solder replacement component lead to conductor pad on both sides of the board.

12-12 ADJUSTMENT AND TEST PROCEDURES

12-13 The following paragraphs provide adjustment instructions and performance criteria for the Model 1037 counters. These adjustments and checks should be performed periodically to assure maximum reliability of the counter, as part of a trouble-shooting procedure to locate malfunctioning circuits, and after repairs and adjustments to assure proper operation before returning the instrument to regular service. In addition, the following applicable paragraphs may be used as an in-cabinet customer acceptance procedure: 12-16, 12-18 through 12-27, 12-28d, 12-30 and 12-33 .

Notes: NOTE
1. Tolerances stated in the following paragraphs are inclusive of the test equipment tolerances.
2. Install the jumper into the plug-in receptacle J-1.

12-14 Power Supply

CAUTION!

When trouble-shooting or adjusting the power supply, do not short output terminals to ground or to each other. This will damage the diodes and transistors.

a. With line power not connected, measure with V.O.M. the resistance to chassis ground from the following pins on J101. Function switch in count. T.B. switch in 10^{-5}. (Negative Probe at ground.)

Table 12-2 Resistance Measurements

Pin Number	Resistance	Ohms Range
Pin Z	7.5 K	1 K
Pin Y	600 Ω	100
Pin W, X	120 Ω	100
Pin S, T	50 Ω	10
Pin M, N	0 Ω	1
Pin P, R	35 Ω	10
Pin U, V	80 Ω	10
Pin L	250 Ω	100
Pin D	570 Ω	100

b. Plug line cord into 60 CPS, 117V Rms source. Turn power switch ON. Observe that fan is operating.

c. Measure with V.O.M. on J101 and adjust the following supplies:
   From Pin U, V adjust the −30 to −30 ±1V
   From Pin W, X adjust the +30 to +30 ±1V
   From Pin S, T adjust the +6 to +6 ±0.3V
   From Pin P, R adjust the −6 to −6 ±0.3V
   From Pin Z adjust the +225 to 225V ±10V
   Measure Pin Y. Should read +42v ± 1V
   Measure Pin L. Should read −24 ±1V
   Measure Pin D. Should read +26 ± 1V

d. Measure with Oscilloscope the following pins on J101. Set time switch to 10 MS/cm. Trigger slope to Line. Measure peak-to-peak ripple. Int./Ext. 1 Mc to Ext.

Pin Z	400 mv P.P. Max. (+225V Line)
Pin W, X	200 mv P.P. Max. (+30V Line)
Pin S, T	100 mv P.P. Max. (+ 6V Line)
Pin R, P	100 mv P.P. Max. (− 6V Line)
Pin U, V	200 mv P.P. Max. (−30V Line)

e. Plug line cord into Variable Autotransformer and connect to line source. Adjust for 105V RMS of line voltage and measure with V.O.M. the following pins on J101.

Pin U, V	−30 ±1V
Pin W, X	+30 ±1V
Pin S, T	+6 ±0.3V
Pin P, R	−6 ±0.3V
Pin Z	+225 ±10V

f. Repeat (e) at 128V RMS of line. Connect instrument directly to line source for balance of tests. Return to Internal 1 Mc position.

12-15 Oscillator and Multiplier

a. Monitor the output at the "1 MC" jack at the rear panel with the oscilloscope. Put "Int-Ext" switch on "Int".
b. Observe base of Q805. Adjust L801 for maximum amplitude.
c. Observe base of Q807. Adjust L802 for maximum amplitude.
d. Observe P800 pin 1. Adjust L803 for maximum amplitude.
e. Repeat steps (b) to (d).

12-16 Time Base

a. Connect oscilloscope to the "Time Base Out" jack. Rotate the Time Base switch through its range and note that the period on the oscilloscope corresponds to the period selected. The output should be 3.0V P.P., minimum in all positions.
b. Place the Ext-Int. switch in the External position. Apply a 1.0V, rms, 1 MC signal to the 1 MC jack on the rear panel. Repeat step (a).
c. Change the input signal to 2.0 MC. Set the Time Base switch to 10 sec., the function switch to "Rate C", and the Display Control to "∞". Depress the reset button and note that the gate light remains on for 5 seconds.
d. Change the input signal to 10 KC. Change the Time Base switch to 10^{-1} sec. Depress the reset button and note that the gate light remains on for 10 seconds.
e. Disconnect the 10 KC signal and return the switch to "Internal." Observe a 2.8 V P.P. ±10%, 1 MC signal at the 1 MC jack.

NOTE
Put display control in '∞' for proceeding checks

12-17 Input Attenuator Adjustment

a. Attach the scope probe to the base of Q101. Connect the square wave generator to the C input. Set frequency of generator to 10 KC, amplitude to 0.4 V peak. Mount 50 MC amplifier card with an extender card. Range switch to "1". Adjust C103 for best square wave.
b. Set amplitude of generator to 4.0 V peak. Range switch to ten. Adjust C101 for best square wave.
c. Set amplitude of generator to 10.0 V peak. Range switch to 100. Adjust C102 for best square wave.

12-18 *Decade and "C" Amplifier Check*

a. Set the function switch to "COUNT C". Connect the time base output to the C input. Set the time base switch to 1 sec and observe that the first indicator (far right) cycles sequentially from 0 through 0. Look for symptoms of defective bi-quinary drive circuitry (two numbers lighting at once, faint glow).

b. Change the time base switch to 10^{-1} sec. Observe the second indicator to confirm the proper sequence of numbers. Repeat the test for the remaining indicators, each time using a time base frequency ten times higher than the previous one.

c. Disconnect the Time Base output. Rotate the trigger control to minus.

d. Press the Reset button. With no input connected, rotate the trigger control to the plus extreme. One count should be registered on the indicators.

e. Rotate the trigger control again towards the opposite extreme. No count should register as the control passes through zero.

12-19 *AC–DC Switch*

a. Connect the low frequency generator to "C" input, amplitude at 100 MV rms. AC-DC switch to "AC." Lowest correct counting rate must be less than 10 cps.

b. Change frequency to 1 cps and AC-DC switch to "DC." Correct counting should be observed.

12-20 *Test Function*

a. Put function switch in the "Test" position. Set the display control for ease of reading. Observe that the indication of the instrument in the various time base switch positions corresponds to Table in par. 3-40

12-21 *Decimal, Legend, and Gate Lights*

a. Observe the decimal and legend (annunciator) lights for correct indication per Tables 12-3 and 12-4, and Figure 12-1

b. Observe that the "Gate" lamp indicates during the counting interval while in the Test function for all settings of the Time Base switch except 10^{-7} and is extinguished during the display interval. (Note: A one-shot circuit keeps the lamp on for a minimum of approximately 10 milliseconds so that it will be visible with very fast time base gating pulses.)

Table 12-3 Time Base Switch Setting

Function Switch Setting	10^{-7}	10^{-6}	10^{-5}	10^{-4}	10^{-3}	10^{-2}	10^{-1}	1	10
Test	*	1	2	3	4	2	3	4	5
Rate	*	1	2	3	4	2	3	4	5
Per A, Tim	2	1	3	2	1	3	2	1	*
Per AX10	3	2	4	3	2	4	3	2	*
Per AX100	4	3	5	4	3	5	4	*	*
Ratio	1	1	1	1	1	1	1	1	1
Ratio X10	2	2	2	2	2	2	2	2	2
Ratio X100[1]	3	3	3	3	3	3	3	3	3

*(S option only)

Table 12-3 Time Base Switch Setting (cont.)

Function Switch Setting	10^{-7}	10^{-6}	10^{-5}	10^{-4}	10^{-3}	10^{-2}	10^{-1}	1	10
Test, Rate Time B-A Per A-X	µs µs	Mc µs	Mc ms	Mc ms	Mc ms	Kc s	Kc s	Kc s	Kc s

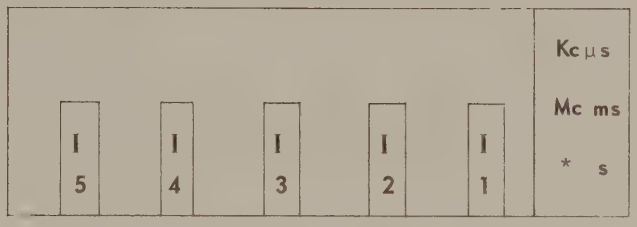


Fig. 12-1 Decimal Light and Indicator Locations

12-22 *Sensitivity and Frequency Range.*

a. Set the range switch to 1, the function switch to RATE C and the time base switch to 1 sec.

b. Connect a test oscillator to the input C of the counter.

c. Vary frequency of test oscillator from 5 Kc to 50 Mc with a constant output of 100 MV RMS. Adjust LEVEL control for stable indication. The counter should display frequencies in this range. Three or four spot checks across the band are sufficient.

12-23 *Period Functions*

a. Change function switch to Per. A. Connect the square-wave generator to C input. Set frequency 100 cps - amplitude 0.3 V P.P. Time Base switch to 10^{-6} sec. Adjust trigger level for stable count. The indication should be 00010000. µs.

b. Change Time Base switch to 10^{-7} sec. The indication should be 0010000.0 µs.

c. Change function switch to Per A x 10. The indication should be 0 10000.00 µs.

d. Change function switch to Per A x 100. Indication should be 10000.000 µs.

e. Plug in the Model 1926A. Connect the generator to the A input. Set both slope switches to +. Adjust trigger level control for A input. The indication should be 10000.000 µs.

12-24 *Time Interval Function*

a. Keep the 100 cps sine wave input. Set both slope switches to "+" and the SEP-COM switch to COM. Change function switch to TIME B-A and the time base switch to 10^{-6} sec. Adjust "B" TRIGGER LEVEL control for a stable count of approximately 00010000.

b. Change both slope switches to "–". The indication should remain the same.

c. Change the B slope switch to "+" and note the reading.

d. Change both slope switches to the opposite polarities and again note the reading. The sum of the readings in step c and d should equal the reading in step a. Return both slope switches to "+".

12-25 Ratio Function

a. Change the function switch to RATIO $\frac{C}{A}$. Keep the 100 cps sine wave to channel A and the 1 Mc sine wave to input C. The indication should be approximately 00010000.

b. Change the function switch to Ratio X10 and note that the reading is 10 times larger than before (but with correct decimal indication).

c. Change the function switch to C/A x 100 and note that the reading is 100 times larger than before. (S option only)

12-26 Gate Function (Not applicable to DIS or S)

a. Keep the 100 cps sine wave input to channels A and B. Apply a 1 Mc sine wave of 1 volt peak-to-peak to the C input.

b. Switch function switch to GATE $\frac{C}{B\text{-}A}$. The indication should be approximately 00010000.

12-27 Display Interval

a. Place the function switch in TEST and select a 1 second time base.
b. Turn the DISPLAY control to maximum without closing the "infinity" switch.
c. Depress the Reset button and then release. The counter should cycle one time and hold its indication for at least 5 seconds.
d. Close the "infinity" switch and note that the counter will not recycle.

12-28 Display Storage (Options D1S and S)

a. Interrogation Pulse – Storage Off Mode

(1) Set the FUNCTION switch to 'COUNT' and the STORAGE/BLANKING switch to 'ON'. Observe the interrogation pulse at the point indicated in Fig. 12.2 on each of the seven decade boards and on the 50 MC readout board.

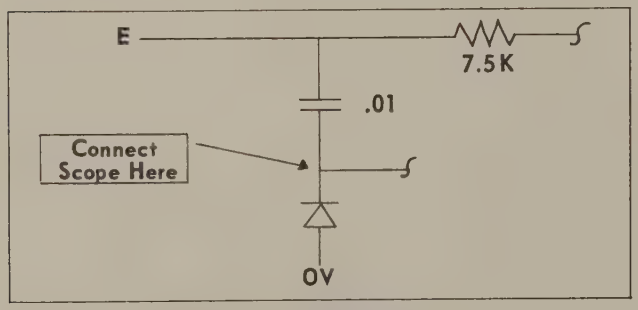


Fig. 12-2 Interrogation Pulse

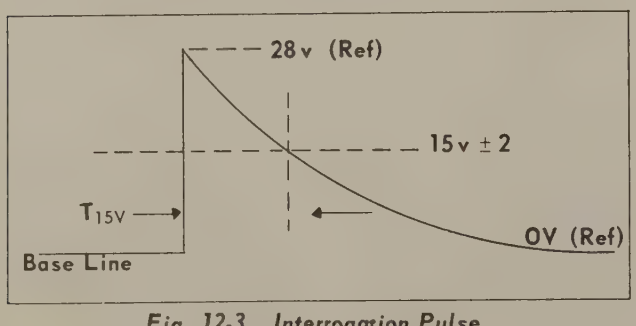


Fig. 12-3 Interrogation Pulse

(2) Check the following (See Fig. 11.3)
Base Line = between −1.0 and 0 volts
T_{15V} = 35 μs minimum

(3) Check the interrogation pulse at the point indicated in Fig. 12.2 on any one of the seven decade boards or the 50 MC readout board, and see that the period is between 5 and 15 milliseconds.

b. Storage Reset Pulse

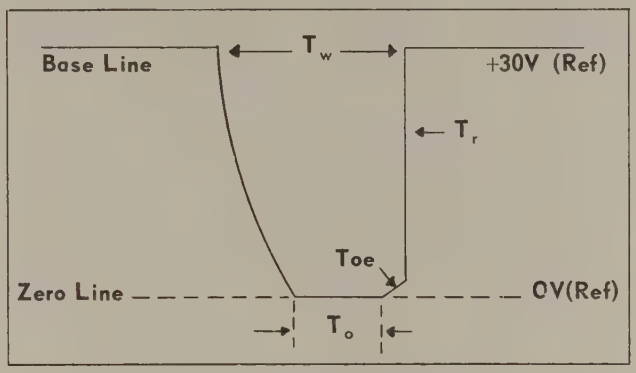


Fig. 12-4 Storage Reset Pulse

(1) Observe storage reset pulse at pin 'E' of J101. Check the following (See Fig. 11.4)
Base Line = within 1.0 volt of the +30 V Bus
Zero Line = between −1.0 and 0 volts
T_o = 40 μs minimum
T_w = between 100 and 500 μs
T_r = (10-90% rise time) = between 2.0 and 6.0 μs
Toe amplitude (if present) = less than 2.0 V

(2) Set the FUNCTION switch to 'RATE', the DISPLAY control to '∞' and the STORAGE/BLANKING switch to 'OFF'. Observe that the waveform on pin 'E' of J101 (Fig. 12.4) has a period of between 5 and 15 milliseconds.

c. Interrogation Timing – Storage On Mode

(1) Set the counter controls:
FUNCTION to 'TEST'
STORAGE/BLANKING to 'ON'
TIME BASE to 10^{-6}
DISPLAY fully CCW

(2) Using a dual trace scope, compare the storage reset pulse at pin 'E', J101, with the 'END OF COUNT' signal (pin 'K', J101) and see that the leading edge (negative going) of Fig. 12.4 corresponds (approximately, in time) with the leading edge (negative going) of the End of Count signal. Check to see that there is one (only) storage reset pulse for each end of count pulse.

d. Operational Check

(1) Storage Off Operation – Position the FUNCTION switch to 'count'. Connect a generator of suitable amplitude and frequency to the counter and check for normal 'COUNT' operation in all 8 indicators.

(2) Storage On Operation
Set the counter controls:
FUNCTION to RATE
STORAGE/BLANKING to ON
DISPLAY fully CCW

12-29 Connect a generator of suitable amplitude and frequency to the counter. Slowly vary the generator output frequency and check that the readout changes only at end of count (gate Light goes out). Check each digit on each of the eight indicators. Time Base may be set to the most convenient position.

12-30 Blanking (Standard 1037 only)

12 31 Turn on the Blanking switch while in the test function and observe that the indicators display only the final count and remain unlit otherwise. With the blanking switch in the "ON" position, rotate function switch to "count" and "hold" positions and note that blanking is defeated in these two functions.

12-32 B Option High-Stability Oscillator Circuit

a. B Option Power Supply
Connect instrument to power source and turn the power switch ON. Using the VOM, measure the voltage on pin E1 of the master oscillator assembly and verify that it is between +24 and +28 volts.

b. ÷3 Circuit
(1) Connect Scope to E3 on the master oscillator and observe a 3 MC, .5V p-p minimum signal.
(2) Connect the Scope to the collector of Q802 on the "÷3 multiplier" board and observe a 3 MC, 8 ±1 V p-p square wave with approximately 50% duty cycle.
(3) Connect the Scope to the emitter of Q806 and observe a 1 MC, 8 ±1 V p-p square wave.

12-33 Oscillator Accuracy Check (All Models)

a. ***General.*** The frequency accuracy of the oscillator may be determined relative to a frequency standard by observing the rate of drift of the oscilloscope pattern as shown by the test set-up in Figure 12 5.

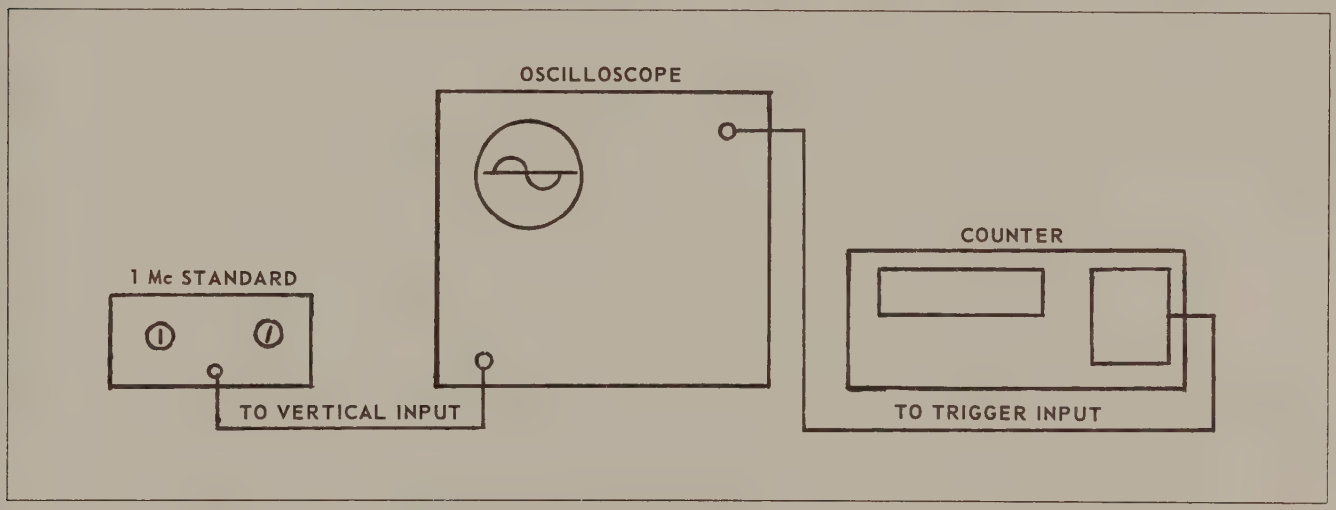


Figure 12-5 Oscillator Accuracy Test Set-up

(1) If the pattern moves to the right, the counter oscillator frequency is lower than the standard frequency. If the pattern moves to the left, the oscillator frequency is higher. The reciprocal of the time in seconds for the pattern to move the width of one cycle equals the frequency difference in parts per 10^6 with a 1 Mc input.

(2) If the pattern drifts to the left with a rate equal to the width of one cycle in 10 seconds, the oscillator frequency is 1 part in 10^7 too high. If the pattern moves the width of one cycle in 100 seconds the error is 1 part in 10^8.

(3) Movement of the pattern may be accurately checked using an oscilloscope with calibrated sweeps by timing the movement of the point at which the oscilloscope trace crosses the base line when the horizontal sweep is expanded and vertical gain is increased.

b. To check oscillator frequency (not stability):

(1) Trigger the oscilloscope externally with the 1 Mc Internal Time Base, available at the rear panel of counter.

(2) Connect a 1 Mc frequency standard to the vertical input of the oscilloscope.

(3) Set the oscilloscope sweep time to .1 μ sec/cm and adjust the controls to obtain a presentation of a 5V peak-to-peak waveform. Use other time scales with faster scopes.

(4) Horizontal drift of the oscilloscope display in cm/sec is the difference between standard frequency in parts per 10^{10}. Adjust the oscillator if necessary to the absolute frequency, as given below and in the specifications.

Table 12-4 Drift vs. Frequency

Drift of Pattern	
1 cm/sec	1 part in 10^7 (0:1 cps)
1 cm/10 seconds	1 part in 10^8 (0 01 cps)
1 cm/100 seconds	1 part in 10^9 (0:00 cps)

NOTE

"B" Oscillator drift rate is certified by the manufacturer to be less than one part in 10^9 per day and decreases with continuous warm-up. Therefore, no re-adjustment should be made unless all test equipment and frequency standards are certified to commensurate accuracy.

12-34 ADJUSTING FREQUENCY USING ERROR EXPANDER

12-35 The most convenient way to set the counter oscillator frequency particularly the high stability oscillator. is by the use of an error expander. Adjustment of the counter oscillator can very quickly be made with a resolution of a part in 10^{10} using this method for adjustment. Several of these are available on the market. The error expander requires a 1 megacycle reference which is used as the basis against which the counter oscillator signal is compared. The 1 MC at the rear panel of the counter is the second input required. The error expander provides an output that has the error expanded by 10, 100 and 1000. When the 10^3 output is connected to the counter input it provides a measurement resolution of 1 part in 10^9 for a one second gate time. Thus. each count in the counter represents one part in 10^9 difference between the 1 MC reference used in the error expander and the 1 MC generated in the counter Correspondingly. for a 10 second gate period the count displayed in the counter represents one part in 10^{10}

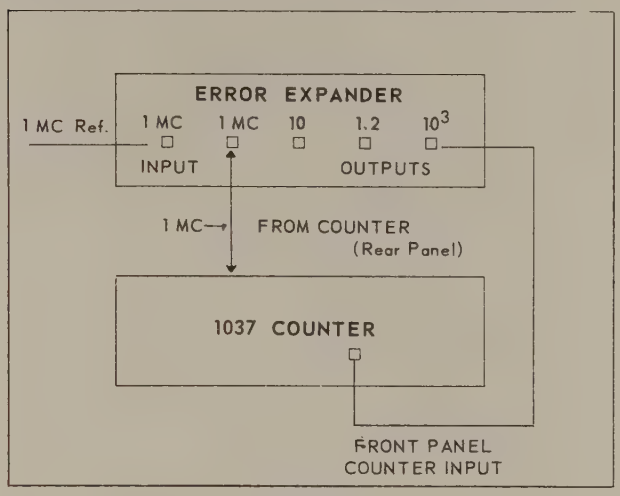


Figure 12-6
Oscillator Frequency Adjustment Using Error Expander

SECTION 13 MASTER PARTS LIST

13-1 PARTS PROCUREMENT

13-2 To obtain replaceable parts, address order or inquiry to the nearest Systron-Donner Engineering Representative, or part manufacturer as applicable. The names and addresses of the Systron-Donner Engineering Representatives located in the continental United States and Canada are listed on the last page of this manual. Please supply as much of the following information as possible when ordering parts.

a. Systron-Donner Stock Number
b. Part Description
c. Part Function and Location

Table 13-1 Master Parts List

SYS-DON PART NO.	DESCRIPTION	MANUFACTURER - PART NO.
CAPACITORS		
C-0235	.001 uf, 3/8" max.	Centralab DD102
C-0325	.005 mf, 10%, 150v, ceramic disc	Centralab DDM-502
C-0354	.22 uf, 20%, 35v	Astron TESP-22-35
C-0406	4.7 uf, 35v, solid tant.	Texas Instru. SCM475BP035A4
C-0417	4 uf, 30v, tant. +75 -15%	G.E. 62F208
C-0441	.01 uf, 400v, ±20%, mylar foil	Hopkins P014MF
C-0524	1.0 uf, 35v, ±20%, tant.	Texas Instru. SCM105FP035D4
C-0527	10 pf, 10%, 500v, dipped silver mica	ElMenco DM-15C-100K-500v
C-0528	15pf, 10%, 500v, dipped silver mica	ElMenco DM-15-C-150K-500v
C-0529	22pf, 10%, 500v, dipped silver mica	ElMenco DM-15C-220K-500v
C-0530	27pf, 10%, 500v, dipped silver mica	ElMenco DM-15C-330K-500v
C-0531	33pf, 10%, 500v, dipped silver mica	ElMenco DM-15E-470K-500v
C-0533	47pf, ±10%, 500v, dipped silver mica	ElMenco DM-15E-820K-500v
C-0535	82pf, 10%, 500v, dipped silver mica	ElMenco DM-15E-820K-500v
C-0536	100pf, 10%, 500v, dipped silver mica	ElMenco DM-15F-101K-500v
C-0537	150pf, 10%, 500v, dipped silver mica	ElMenco DM-15F-151K-500v
C-0538	220pf, ±10%, 500v, dipped silver mica	ElMenco DM-15F-221K-500v
C-0539	270pf, 10%, 500v, dipped silver mica	ElMenco DM-15F-271K-500v
C-0540	330pf, ±10%, 500v, dipped silver mica	ElMenco DM-15F-331K-500v
C-0541	390pf, ±10%, 500v, dipped silver mica	ElMenco DM-15F-391K-500v
C-0542	470pf, ±10%, 300v, dipped silver mica	ElMenco DM-15F-470K-300v
C-0543	1000pf, ±10%, 100v, dipped silver mica	ElMenco DM-15F-102K-100v
C-0544	2000pf, ±10%, 500v, dipped silver mica	Mica Mold MOC-202K
C-0562	.01uf, +80 -20%, 50v ceramic disc	Sprague 19C214
C-0564	.10uf, ±20%, 100v, metalized paper	Electron ME1-104
C-0596	5 pf, 10%, 500v, dipped silver mica	ElMenco DM-15C-050-500v
C-0628	100pf, 10%, 500v, dipped silver mica	ElMenco DM-19F-101K-500v
C-0632	.25 uf, 5%, 100v, mylar	Hopkins P252MC
C-0635	68 pf, ±10%, 500v, dipped silver mica	ElMenco DM-15E-680K-500v
C-0638	680pf, ±10%, 300v, dipped silver mica	Mica Mold MQ-C681K
C-0643	180pf, 10%, 500v, dipped silver mica	ElMenco DM15F-181K-500v
C-0661	0.1uf, ±20%, 10v, ceramic disc	C.R.L. UJ10-104
C-0664	20uf, ±10%, 50v electrolytic	Sprague 40D195A2
C-0672	.05 uf, +80 -20%, 12v, disc	Magnacap R.M.C.
C-0681	820pf, 10%, 300v, dipped silver mica	ElMenco DM-15F-821K-300v
C-0705	.01uf, 10%, 50v, metalized mylar	G.E. 65F10AC103
C-0706		
C-0708	.05uf, +80 -20%, 50v, ceramic disc	Sprague 55C23
C-0709	9 - 35 pf, trimmer	Erie 538-011-E2PO-94R
C-0712	5.5 - 18 pf, trimmer	Erie 538-011-NP05.5-18
C-0732	120 uf, ±20%, 10v	Kenet K120P10
C-0733	.47 uf, 35 - 42v, 20%, tant. solid	G.I. MCSF4-74M
C-0759	3000 pfd, 5%, 500v, dipped silver mica	Arco DM19-302J
C-0760	1500 pf, 5%, 500v, dipped silver mica	Arco DM19-152J
C-0800	1000 uf (each) 50v, double	Sangamo Elec. 505-3802-01
5-13490	1000 uf, 65v	Sprague C-13490
5-13491	33 ufd, 400v	Sprague C-13491

SYS-DON. PART NO.	DESCRIPTION	MANUFACTURER - PART NO.
DIODES		
CR-0064	Type 1N752A, Zener 5.6v	
CR-0072	Type 1N759, 12v, silicon regular	Texas Instruments
CR-0095	Type 1N751A	
CR-0132	Type 1N716, Zener 12v, 1/4w	International Rectifier
CR-0148	Type DI-52	Diodes, Inc. DI-52
CR-0149	Type DI-54, silicon rectifier	Diodes, Inc. DI-54
CR-0150	Type CD 6262, silicon rectifier	Continental Devices
CR-0173	Type 1N3712, tunnel diode	General Electric
CR-0188	Type 1N3719, tunnel diode	General Electric
CR-0189	Type 1N3605, tunnel diode	General Electric
CR-0194	Type Q6-100	International Diode
CR-0224	Type 1N3030A, zener 27v, 5%, 1w	Motorola 1N3030A
CR-0228	Type 1N984B, zener	
6-6700	Type 6700, per S-D Spec.	1N276
FUSE		
F-0019	Fuse, 1.5A Slo Blo	
F-0043	Fuse, 3AG, .25A, Quick Acting	Littlefuse 312-250
INDUCTORS		
L-0053	Choke, 6.8 uh	Essex WEE 6.8
L-0055	Coil, 24v	Coto Coil U-24P
13-15320-1	Inductor, Variable Assembly 1 uh	S-D Corp.
13-15320-2	Inductor, Variable Assembly 3.3 uh	S-D Corp.
TRANSISTORS		
Q-0028	Type 2N697	Fairchild
Q-0073	Type 2N1304	Texas Instruments
Q-0075	Type 2N1306	Texas Instruments
Q-0080	Type 2N1183	RCA
Q-0084	Type 2N1671B	G.E.
Q-0102	Type 2N2270	RCA
Q-0104	Type 2N2142	Motorola
Q-0130	Type 2N706	Philco
Q-0131	Type 2N2201	
Q-0136	3N58 Silicon	G.E.
Q-0157	Type 2N3251	Motorola
Q-0158	Type 2N2708	RCA
Q-0166	Type 40251	RCA
Q-0170	Type 2N1546	Motorola
Q-0171	Type 2N2146	Motorola
Q-0174	Type 2N3251	
Q-6724		
19-6727	Per S-D Spec.	2N1304 equivalent
19-14000	Transistor 14000, per S-D Spec.	2N964 equivalent
19-14092	Transistor 14092, per S-D Spec.	2N709 equivalent
19-15700	Transistor 15700, per S-D spec.	2N404 equivalent
19-15840	Transistor 15840, per S-D Spec.	2N3440 equivalent
19-15850	Transistor 15850, per S-D Spec.	2N3440 equivalent

RESISTORS

SYS-DON. PART NO.	DESCRIPTION
R-0136	3.3K, ±5%, 1/2w
R-0137	56K, ±5%, 1/2w
R-0143	2.7K, ±5%, 1/2w
R-0144	47K, ±5%, 1/2w
R-0150	1M, ±5%, 1/2w
R-0200	7.5K, ±5%, 1/2w
R-0230	43K, ±5%, 1/2w
R-0252	75K, ±5%, 1/2w
R-0259	2.2K, ±5%, 1/2w
R-0260	1.2K, ±5%, 1/2w
R-0263	330K, ±5%, 1/2w
R-0264	220K, ±5%, 1/2w
R-0265	1.5K, ±5%, 1/2w
R-0273	68K, ±5%, 1/23
R-0276	1K, ±5%, 1/2w
R-0277	1.8K, 5%, 1/2w
R-0278	1K, ±5%, 1/2w
R-0292	10K, ±5%, 1/2w
R-0293	120K, ±5%, 1/2w
R-0309	1.2K, 5%, 1/4w
R-0315	330Ω, 5%, 1/2w
R-0321	680Ω, ±5%, 1/2w
R-0330	1K, ±10%, 2s
R-0351	2.5K, ±5%, 1/2w
R-0352	100K, ±5%, 1/2w
R-0354	10Ω, ±5%, 1/2w
R-0355	150K, ±5%, 1/2w
R-0356	100K, ±5%, 1w
R-0365	270Ω, ±5%, 1/2w
R-0424	30Ω, ±5%, 1/2w
R-0431	110Ω, ±5%, 1/2w
R-0466	100Ω, ±5%, 1/2w
R-0472	8.2K, ±5%, 1/2w
R-0474	15K, ±5%, 1/2w
R-0479	91K, ±5%, 1/2w
R-0492	1.2K, ±10%, 1w
R-0514	6.8K, ±5%, 1/2w
R-0522	4.7K, ±5%, 1/2w
R-0527	22K, ±5%, 1/2w
R-0562	5.6K, ±5%, 1/2w

Unless otherwise noted, all resistors are composition carbon by Allen-Bradley.

SYS-DON. PART NO.	DESCRIPTION
R-0564	27K, ±5%, 1/2w
R-0576	67K, ±5%, 1/2w
R-0585	36K, ±5%, 1/2w
R-0616	3.9K, ±5%, 1/2w
R-0619	27K, ±5%, 2w
R-0643	1.8K, ±10%, 1w
R-0662	330Ω, ±5%, 1/4w
R-0670	300Ω, ±5%, 1/4w
R-0677	470Ω, ±5%, 1/2w
R-0694	370Ω, ±5%, 1/4w
R-0695	43K, ±5%, 1/4w
R-0696	6.8K, ±5%, 1/4w
R-0702	4.3K, ±5%, 1/4w
R-0705	36K, ±5%, 1/4w
R-0711	3K, ±5%, 1/4w
R-0715	30K, ±5%, 1/4w
R-0720	3.3K, ±5%, 1/4w
R-0721	2.2K, ±5%, 1/4w
R-0724	39Ω, ±5%, 1/2w
R-0725	180Ω, ±5%, 1/2w
R-0728	15K, ±5%, 1/4w
R-0734	2K, ±5%, 1/4w
R-0736	200Ω, ±5%, 1/4w
R-0739	10Ω, ±5%, 1/4w
R-0741	100K, ±5%, 1/4w
R-0742	3.3K, ±5%, 1/4w
R-0743	47Ω, ±5%, 1/4w
R-0748	39K, ±5%, 1/4w
R-0749	2.2K, ±5%, 1/4w
R-0759	12K, ±5%, 1/4w
R-0760	220Ω, ±5%, 1/4w
R-0762	820Ω, ±5%, 1/4w
R-0765	1K, ±5%, 1/4w
R-0766	10K, ±5%, 1/4w
R-0768	22K, ±5%, 1/43
R-0776	9.1K, ±5%, 1/43
R-0777	47K, ±5%, 1/4w
R-0780	33K, ±5%, 1/4w
R-0783	1.5K, ±5%, 1/4w
R-0784	82K, ±5%, 1/4w
R-1287	Pot. 2w EZ Trip
R-1288	Trimpot, 1K, 1/2w, ±10%
R-1317	Pot. 500Ω, 1/2w, w.w. EZ trim
R-1498	100K, ±2%, 1/2w, metal film
R-1499	120K, ±2%, 1/2w, metal film
R-1596	22K, ±2%, 1w
R-1661	2Ω, 2w, wire wound
R-1665	Pot. 5K, ±30%, 1/4w

SYS-DON. PART NO.	DESCRIPTION
R-0785	18K, ±5%, 1/4w
R-0807	120K, ±5%, 1/4w
R-0809	1.2K, ±5%, 1/4w
R-0819	560Ω, ±5%, 1/4w
R-0821	5.6K, ±5%, 1/4w
R-0823	200K, ±5%, 1/4w
R-0824	27K, ±5%, 1/4w
R-0835	240Ω, ±5%, 1/4w
R-0875	100K, ±5%, 1/4w
R-0879	10K, ±5%, 1w
R-0880	390Ω, ±5%, 1/4w
R-0883	8.2K, ±5%, 1/4w
R-0884	7.5K, ±5%, 1/4w
R-0892	4.7K, ±5%, 1/4w
R-0937	2.7K, ±5%, 1/4w
R-0939	3.9K, ±5%, 1/4w
R-0962	1M, ±5%, 1/4w
R-0965	6.2K, ±5%, 1/4w
R-0966	100Ω, ±5%, 1/4w
R-0971	62K, ±5%, 1/4w
R-0976	75K, ±5%, 1/4w
R-0983	150Ω, ±5%, 1/4w
R-0984	510Ω, ±5%, 1/4w
R-1044	470Ω, ±5%, 1/4w
R-1059	82Ω, ±5%, 1/4w
R-1083	560Ω, ±5%, 1/2w
R-1113	10K, ±10%, 2w
R-1116	47K, ±5%, 2w
R-1233	180Ω, 1/4w, 5%
R-1234	680Ω, ±5%, 1/4w
R-1235	56K, ±5%, 1/4w
R-1246	51Ω, ±5%, 1/4w
R-1295	240Ω, ±5%, 2w
R-1313	30Ω
R-1425	750Ω, ±5%, 1/4w
R-1436	
R-1549	30Ω, ±5%, 1/4w
R-1556	75Ω, ±5%, 1/4w
R-1571	360Ω, ±5%, 1/4w
R-1573	1K, ±5%, 2w
R-1589	36K, ±5%, 2w
R-1590	620Ω, ±5%, 1w
R-1593	
R-1667	430Ω, ±5%, 1/4w
R-1668	560Ω, ±5%, 1w
R-1669	1.1K, ±5%, 1w
R-1701	3K, ±5%, 1/2w
R-1868	270Ω, ±5%, 3w
R-1089	1K, ±5%, 1w

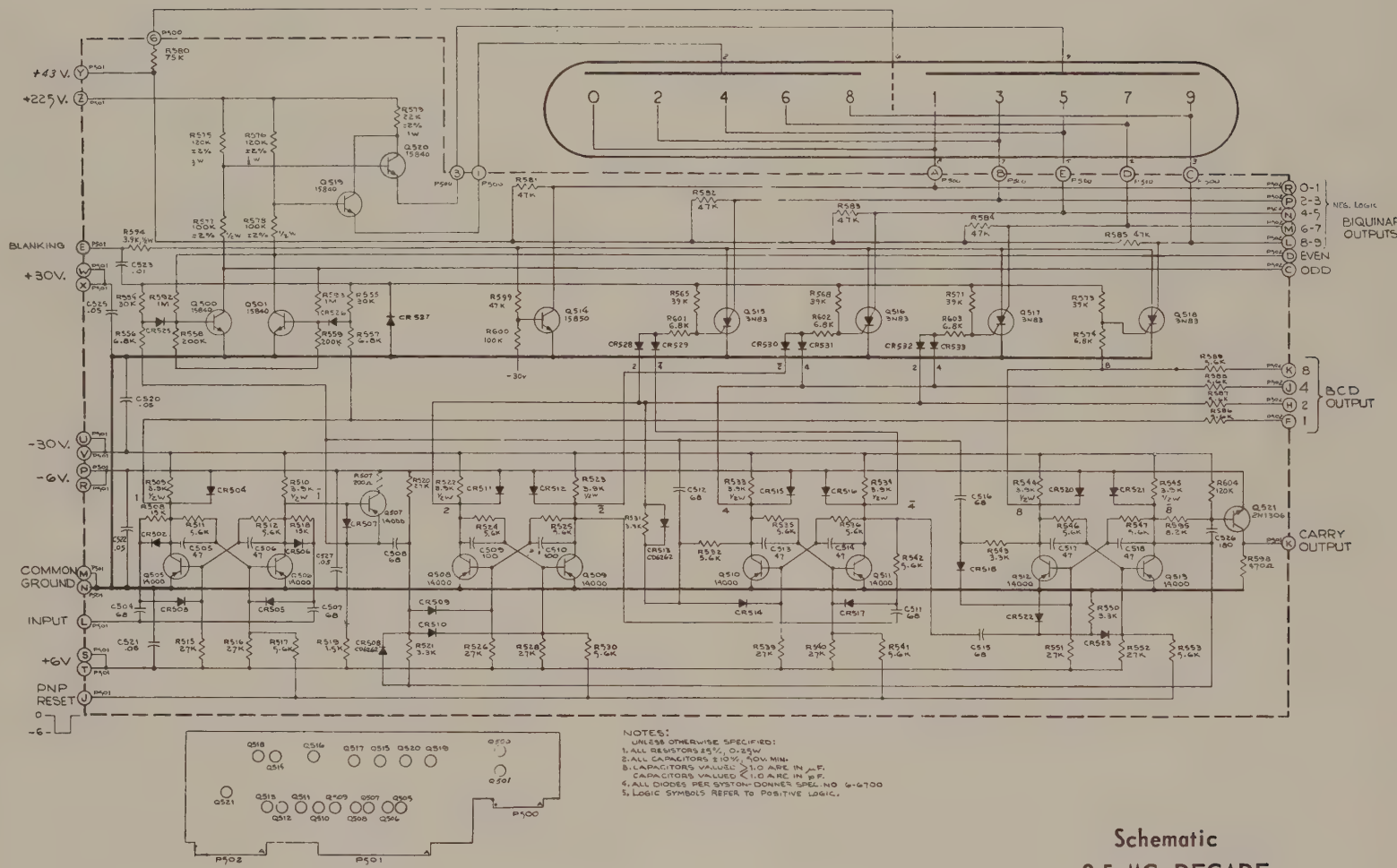
TRANSFORMERS

		Manufacturer
T-0083		
T-0084	1:1 T801	
T-0085	6:1 T802	
1-13516	Insulation, Trans.	S-D Corp.
9-15326	Foil, Trans.	S-D Corp.
23-12740	Transformer	Tranex 23-12740

Part No.	Description	Ref.
15452	FINAL ASSEMBLY	
15439	Panel, Front, Assembly	
15440	Panel, Front S.S. Assy	
15962	Time Base-Function Sw. Cable Assy	
15963	Time Base Sw. Jumper & Loose Wire Assembly	
15961	Wire Prep. Assy	
15964	Function Sw. Jumper & Loose Wire Assy	
17004	Wire Prep. Assy	
17002	Mother Bd #1 PC Bd Assy	
16155	Loose Wire Prep. Assy	
15459	Annunciator Assy	
15718	Range Sw. Level Control Cable Assy	
15455	Rear Panel Assy	
15448	Power Supply Assy	
15965	Connector J1 Cable Assy	
15966	Wire Prep. Assy	
15412	Power Supply PC Bd Assy	
15458	Mother Bd #2 PC Bd Assy	
15394	Chassis Assembly	
16152	Connector J7 Cable Assy	
16151	Wire Prep. Assy	
10504	250KC Stand. Decade PC Bd Assy	
13269	2.5MC Stand. Decade PC Bd Assy	
15116	10MC Stand. Decade PC Bd Assy	
12242	50MC Readout Decade PC Bd Assy	
15391	Display & Reset PC Bd Assy	
11095	Multiplier & Osc. PC Bd Assy	
13534	50MC Amplifier PC Bd Assy	
15422	Time Base PC Bd Assy	
11523	250KC Storage Decade PC Bd Assy	
11527	2.5MC Storage Decade PC Bd Assy	
15200	10MC Storage Decade PC Bd Assy	
12970	50MC Readout Decade PC Bd Assy	
12983	Multiply + 3 PC Bd Assy	
12970	Power Supply PC Bd Assy	
15439	FRONT PANEL ASSEMBLY	
15440	Panel, Front, S.S. Assy	
15581	Art Work	
15415	Panel Front	
17007	Panel, Front Blank	
15962	Time Base-Function Sw. Cable Assy	
15963	Time Base Sw. Jumper & Loose Wire Assy	
15213	Time Base Sw	S1
15961	Wire Prep. Assy	
16141	Wire PVC, per Std Wire List	
15964	Function Sw. Jumper & Loose Wire Assy	
15214	Function Switch	S2
17004	Wire Prep. Assy	
16141	Wire #22 PVC per Std. Wire, Coax RG-196/U	
H-0955	Ferrule	
TS-0024	Thermal Sleeving	
H1104	Cable Tie	
16155	Loose Wire Prep. Assy	
15459	Annunciator Assy	
15718	Range Sw-Level Control Cable	
E-0137	Lug, Ground, BNC Type	
11342	Lock, Panel	
13548	Knob, Black, 1/4" dia. shaft	
13547	Knob, Black, 1/8" dia. shaft	
J-0260	Connector, BNC	J2
S-0073	Switch, Toggle, DPDT	S7
S-0140	Switch, Pushbutton SPST	S8
11637	Knob Spec. Dual Control	
11636	Knob Spec. Single Shaft	
15404	Bracket, Window	
11066	Window	
15405	Bracket, PC Mtg.	
I-0055	Lamp, Pilot w/33K 1/4w Res. amber	I1
I-0047	Lamp, Pilot 3/150K 1/2w Res. Red	I2
H-1271	Screw, Tapping #2x1/4" Type B	
H-0988	Screw, Flat Hd. 6-32x1/2 Ph NPS	
H-1282	Washer, Lock #4 Int Tooth CPS	
H-1273	Screw Pan Hd 4-40x5/16 Ph CPS	
H-0984	Screw Pan Hd 6-32x3/8 Ph CPS	
H-0410	Washer, Lock #6 Int. Tooth CPS	

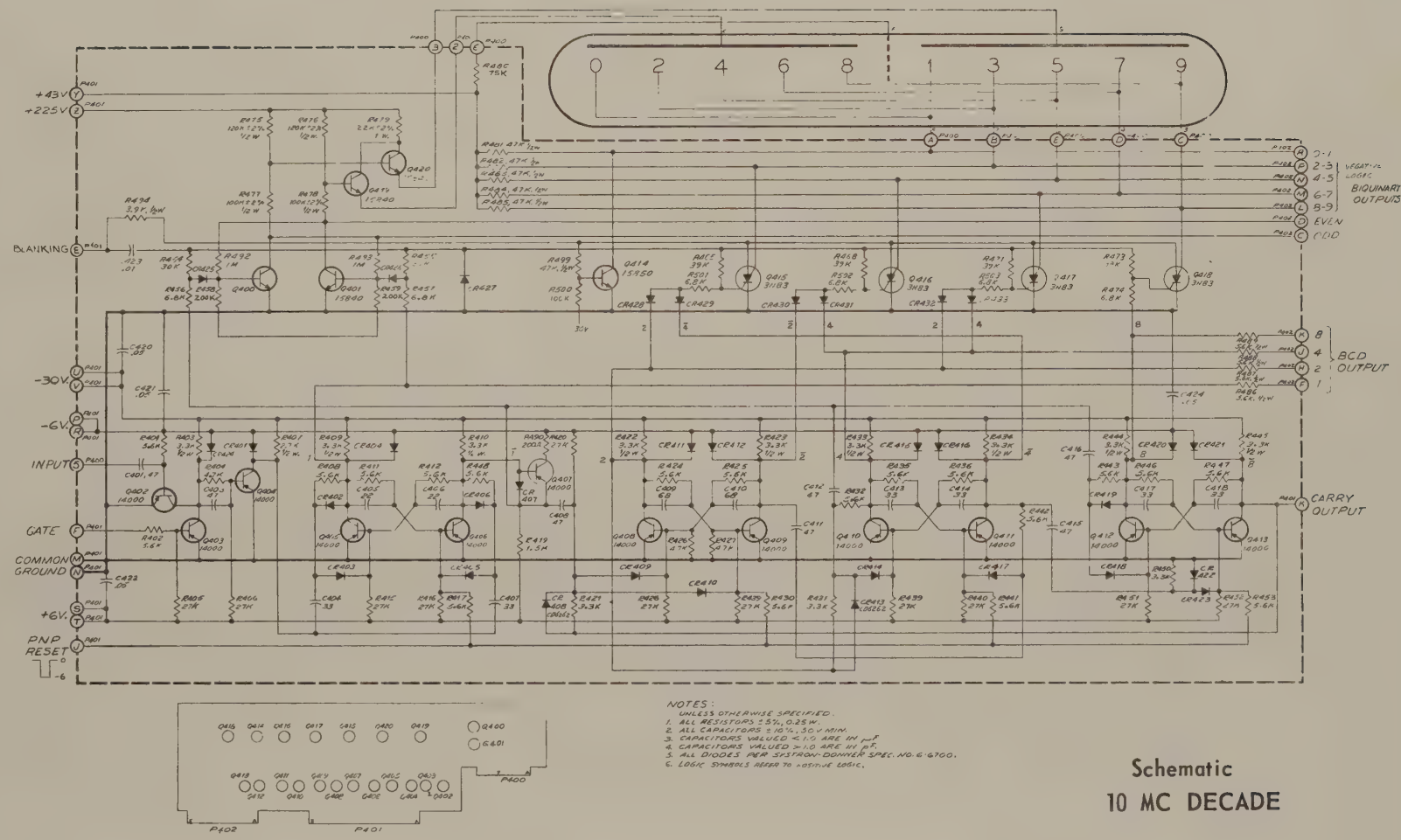
Part No.	Description	Ref.
17002	MOTHER BOARD NO. 1 PC ASS'Y	
16160	Mother Bd #1 PC Board	
17000	Artwork Mother Bd #1	
16046	Insulator, Socket	
X-0078	Socket, 9 Contacts	
J-0262	Connector, 20 Contacts	
13550	Connector, 12 Contacts	
10052	Indicator	I8
		I9
		I10
		I11
	Same as I8	I12
15455	REAR PANEL ASSEMBLY	
15658	Panel, Rear SS Assy	
12876	Artwork	
15456	Panel, Rear Welding Assy	
15457	Panel, Rear	
H-0390	Weld Nut 4-40	
H-03969	Weld Nut 6-32	
11115	Screen	
11096	Plug Plate	
15681	Fan Guard Assy	
15679	Cover, Fan Guard	
15680	Screen, Fan Guard	
15711	Fan Motor & Blade Assy	B1
B-0013-1	Fan Motor	
B-0013-2	Fan Blade	
B-0013-3	Screw 3-48	
15969	Rear Panel Cable Assy	
15970	Wire Prep. Assy	
	Wire Belden 8451 2 Cond.	
	Wire, Coas R6-196/U	
	Wire, 22 Ga PVC per wire std. 16141	
40955	Ferrule	
TS-0024	Thermal Sleeving	
H-1104	Cable Tie	
W-0004	Cord, AC Line	
X-0034	Holder, Fuse	
J-0260	Connector, BNC	J3
S-0110	Switch Slide, DPDT	S4
	Same as Se	S6
E-0137	Lug Ground, BNC Type	
H-0383	Heyco Nut	
H-0404	Rivet 1/8 dia 1/8 long	
H-0819	Screw, Pan Hd. 4-40x3/4 NPS	
H-1049	Screw, Pan Hd. 6-32x1/2 NPS	
H-0657	Screw, Pan Hd. 4-40x5/16 NPS	
H-0410	Washer, Lock #6 Int. tooth CPS	
H-0248	Washer, Lock #4 Int. tooth NPS	
15458	MOTHER BOARD NO. 2 P.C. ASS'Y	
16159	Mother Bd #2 PC Board	
17001	Artwork	
X-0103	Socket Octal	
J-0228	Connector, 22 Contacts	
J-0272	Connector, 15 Contacts	
E-0191	Terminal (18 Ga Wire)	
C-0424	Capacitor, .001 mfd 500v Disc	C1
C-0441	Capacitor, .01 mfd	C8

SYS-DON PART NO.	DESCRIPTION	MANUFACTURER - PART NO.
MISCELLANEOUS		
E-0100	Terminal, Space Lug P.C.	USECO
E-0112	Solder Lug #8, Int. Tooth	
E-0146		
E-0184	Coil Forms with Adj. Core	Delevan Elec. DEL 6/C
H-0146	Transistor Pad Coupling, Solid	Pacific Wholesale
H-0376	Screw, 4-40x3/8"Cad. Plt'd BHMS	
H-0377		
H-0393		
H-0481		
H-0515	Transistor Mtg Pad	Delbert Blinn TP 501
H-0516	Screw, Mach. 6-32x1-1/2" CPS	
H-0606	Grommet 1/2" dia mtg	Rubbercraft
H-0658	Washer, Int. Tooth #8, .33 OD nom. x1/64"	
H-0726		
H-0727		
H-0746	Washer, Lock, Int. tooth #6 CPS	
H-0749	Nut, 6-32 lug, Pattern C.P.S.	
H-0791		
H-0940	Drive Rivets, Aluminum S.S. Pins	Southco 38-104-06-13
H-0941	Nylon Bushing 6x1/4" length	Machine Part Co., N.Y.
H-0980		
H-1033	Screw, 8-32x3/8, C.P.S., Phillip hd	
H-1055	Thermal Compound	Wakefield 122
H-1104		
H-1155	Washer, Shldr 5/16", Fiber #6	G.C. #6525C
H-1182		
H-1275		
I-0041	Lamp	
J-0170	Connector 50 pin (See P/L 17013)	
S-0132	Reed Relay Contacts, N.O., Magnetic Reed	Gordos Corp MR400-1
X-0127	Fuse Holder for 3AG fuses, 5 pole	Littlefuse 357005
9669	PC Bd. Stiffener	
11529	PC Bd (10MC)	
12241	50MC Readout Bd.	
13269		
14599-1		
14899-1		
15200	10MC Storage Decade Assy	
15371	SS Assy	
15674	1-2-4-8 Option Bd	



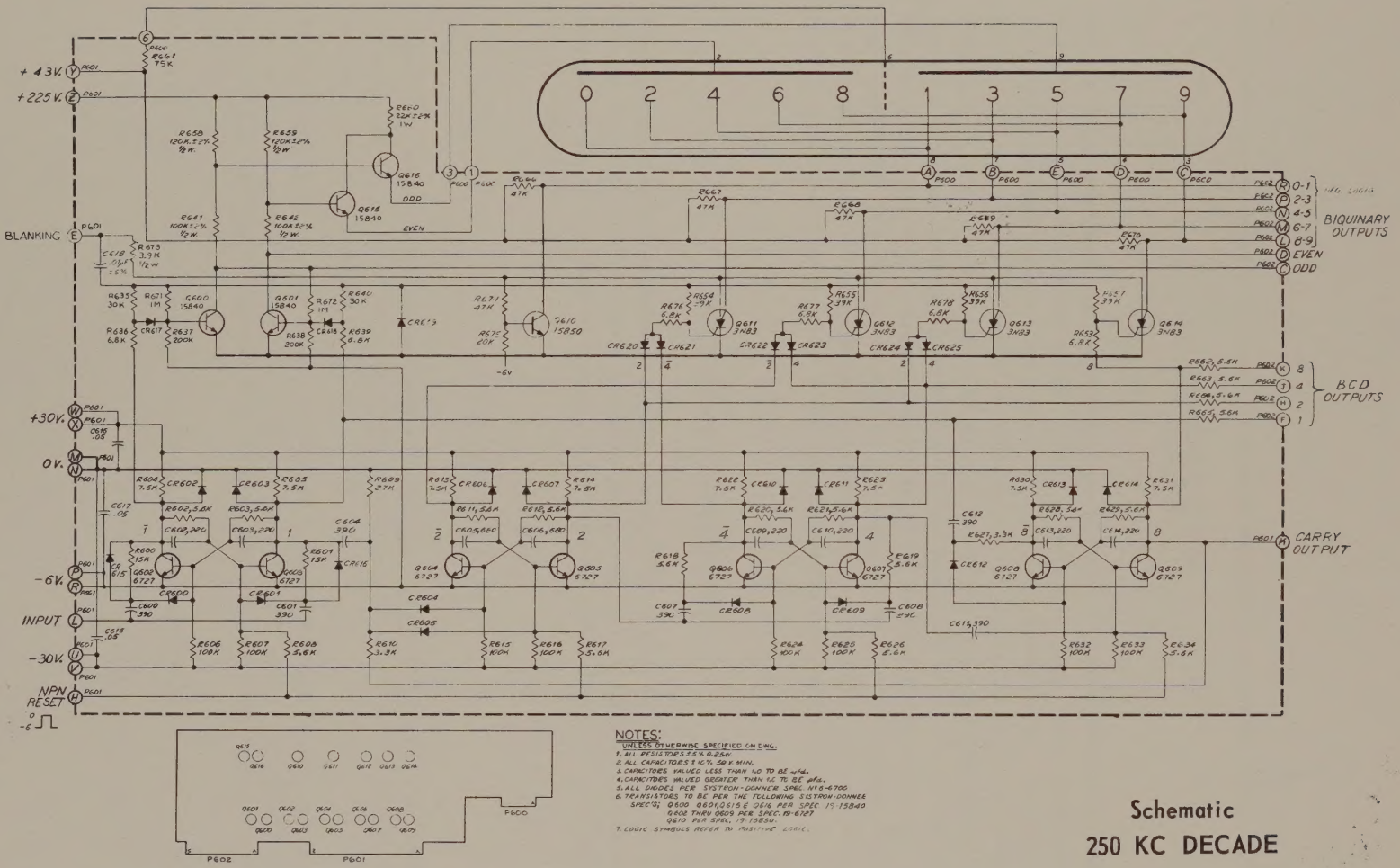
NOTES:
UNLESS OTHERWISE SPECIFIED:
1. ALL RESISTORS ±5%, 0.25W
2. ALL CAPACITORS ±10%, 50V. MIN.
3. CAPACITORS VALUED ≥1.0 ARE IN μF.
CAPACITORS VALUED <1.0 ARE IN μμF.
4. ALL DIODES PER SYSTON-DONNER SPEC. NO 6-6700
5. LOGIC SYMBOLS REFER TO POSITIVE LOGIC.

Schematic
2.5 MC DECADE



NOTES:
UNLESS OTHERWISE SPECIFIED.
1. ALL RESISTORS ±5%, 0.25 W.
2. ALL CAPACITORS ±10%, 300 V MIN.
3. CAPACITORS VALUED < 1.0 ARE IN μF.
4. CAPACITORS VALUED ≥ 1.0 ARE IN pF.
5. ALL DIODES PER SYLVANIA-SPEC. NO. 6-6700.
6. LOGIC SYMBOLS REFER TO POSITIVE LOGIC.

Schematic
10 MC DECADE



NOTES:
UNLESS OTHERWISE SPECIFIED ON ENG.
1. ALL RESISTORS ± 5% ½ Watt.
2. ALL CAPACITORS ± 10% 50 V. MIN.
3. CAPACITORS VALUED LESS THAN 1.0 TO BE μμf.
4. CAPACITORS VALUED GREATER THAN 1.0 TO BE μf.
5. ALL DIODES PER SYSTRON-DONNER SPEC. NO 6706
6. TRANSISTORS TO BE PER THE FOLLOWING SYSTRON-DONNER SPEC'S; Q600 Q601, Q615 & Q616 PER SPEC 19-13840 Q602 THRU Q609 PER SPEC. 19-6727 Q610 PER SPEC. 19-13850.
7. LOGIC SYMBOLS REFER TO POSITIVE LOGIC.

Schematic
250 KC DECADE

WARRANTY

Systron-Donner instruments are warranted during a period of one year from date of shipment to original purchaser to be free from defects in material and workmanship. This warranty does not apply to vacuum tubes, except as they are warranted by tube manufacturers. The liability of Seller under this warranty is limited to replacing or repairing any instrument or component thereof which is returned by Buyer at his expense during such period and which has not been subjected to misuse, neglect, improper installations, repair, alteration, or accident. Seller shall have the right of final determination as to the existence and cause of a defect. In no event shall Seller be liable for collateral or consequential damages. This warranty is in lieu of any other warranty, express, implied or statutory, and no agreement extending or modifying it will be binding upon Seller unless in writing and signed by a duly authorized officer.

RECEIVING INSPECTION

Every Systron Donner instrument is carefully inspected and is in perfect working order at the time of shipment. Each instrument should be checked as soon as received. If the unit is damaged in any way or fails to operate, a claim should immediately be filed with the transportation company.

REPAIRS

Whenever a Systron-Donner instrument requires service, the nearest Systron-Donner representative should be contacted; all representatives will provide immediate service or arrange factory returns when necessary.

Please specify both model and serial number in all correspondence concerning Systron-Donner instruments. Address all inquiries on operation or applications to your nearest sales representative or Sales Manager, Instruments, Systron-Donner Corporation, 888 Galindo Street, Concord, California.

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